



May 2023

# AVIATION WORKFORCE

## Current and Future Availability of Airline Pilots and Aircraft Mechanics

Accessible Version

# GAO Highlights

Highlights of [GAO-23-105571](#), a report to congressional committees

## Why GAO Did This Study

The aviation industry has raised questions about whether the demand for commercial airline pilots and aircraft mechanics may exceed supply in the future. Industry's demand for pilots and mechanics is driven by a number of factors. These include projected demand for air travel and the number of aircraft that airlines expect to use to fulfill that demand, as well as anticipated workforce attrition and retirements.

The FAA Reauthorization Act of 2018 includes a provision for GAO to study the aviation and aerospace workforce of the future, including the current and future supply of individuals in the workforce. This report examines the supply of and demand for 1) commercial airline pilots and 2) aircraft mechanics; and examines 3) actions the aviation industry and FAA have taken to address workforce supply concerns, among other objectives.

GAO reviewed government and industry labor supply, employment, and wage data for 2017 through 2022 using the most recent data available at the time of the analyses; and several government and private sector aviation forecasts. GAO reviewed relevant federal laws and regulations and FAA documentation including rulemaking documents. GAO interviewed officials from FAA and representatives from a non-generalizable sample of 25 aviation industry stakeholders. These included airlines, collegiate flight schools, aviation maintenance schools, repair stations, labor unions, aviation consultants and academics, and industry associations.

DOT reviewed a draft of this report and provided technical comments, which were incorporated as appropriate.

View [GAO-23-105571](#). For more information, contact Heather Krause at (202) 512-2834 or [krauseh@gao.gov](mailto:krauseh@gao.gov).

May 2023

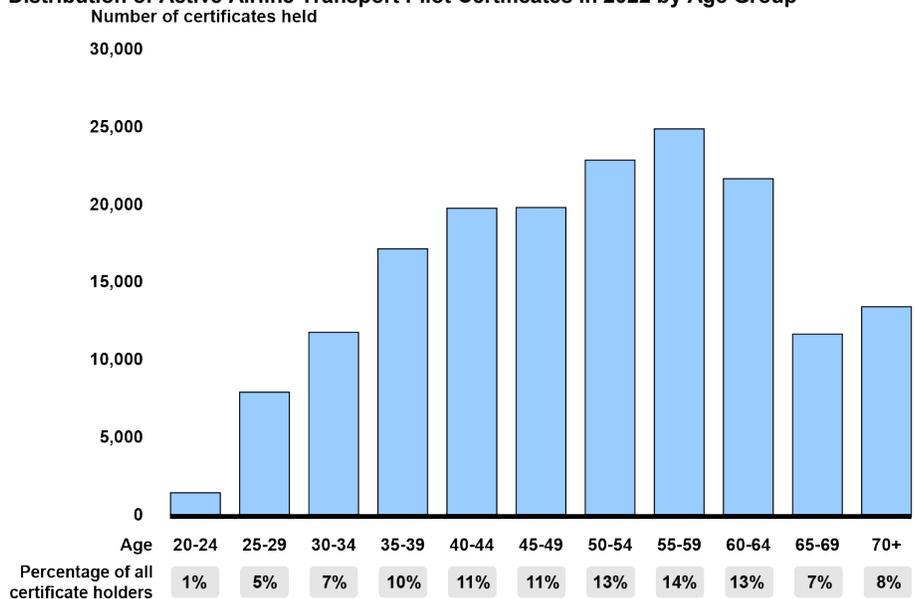
## AVIATION WORKFORCE

### Current and Future Availability of Airline Pilots and Aircraft Mechanics

## What GAO Found

Current pilot supply—as measured by the number of individuals qualified to be U.S. passenger airline pilots—grew from 2017 through 2022. Enrollments in pilot training schools also increased in recent years. Based on the Federal Aviation Administration's (FAA) forecasts and pilot certification data, the number of these pilots under the current mandatory retirement age of 65 may increase over the next 20 years. However, the extent to which projected supply would exceed or fall short of industry's demand for pilots is unknown given uncertainties surrounding future demand. Publicly available data on hiring, employment, and wages indicate strong current demand for pilots. Meeting that demand has been particularly difficult for regional airlines—which generally serve smaller communities—and has, according to them, affected their operations.

**Distribution of Active Airline Transport Pilot Certificates in 2022 by Age Group**



Source: GAO analysis of Federal Aviation Administration information. | GAO-23-105571

**Data for Distribution of Active Airline Transport Pilot Certificates in 2022 by Age Group**

Age	Number of ATP Certificates Held	Percentage of certificates held
20-24	1496	1
25-29	7982	5
30-34	11846	7
35-39	17229	10
40-44	19842	11
45-49	19890	11
50-54	22949	13
55-59	24955	14
60-64	21745	13

<b>Age</b>	<b>Number of ATP Certificates Held</b>	<b>Percentage of certificates held</b>
65-69	11730	7
70+	13484	8

Source: GAO analysis of Federal Aviation Administration information. | GAO-23-105571

Note: Pilots age 65 and over are no longer eligible for employment with scheduled U.S. passenger airlines, but could work as pilots or instructors elsewhere.

The number of people newly certificated by FAA to be aircraft mechanics grew from 2017 through 2022. Less is known about how many mechanics enter or exit the aviation industry each year and the extent of demand for aircraft mechanics. Nevertheless, aviation businesses GAO interviewed reported challenges maintaining sufficient numbers of mechanics.

Aviation industry stakeholders have taken steps to address workforce supply concerns. Airlines and repair stations are increasing pay for pilots and mechanics. For example, several regional airlines raised pay substantially in 2022. Airlines are also creating flight schools. FAA is undertaking efforts to support industry workforce development, including awarding grants to attract young people to aviation careers.

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# Contents

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GAO Highlights		ii
	<b>Why GAO Did This Study</b>	ii
	<b>What GAO Found</b>	ii
Letter		1
	Background	5
	Pilot Supply Has Grown, and Demand for Pilots is Projected to Continue to Be Strong	12
	Available Data Provide Limited Information on Aircraft Mechanic Supply and Demand	20
	Selected Aviation Stakeholders Identified Continuing Challenges to Increasing the Supply of Pilots and Mechanics	24
	Aviation Businesses are Taking Various Actions to Address Workforce Supply Concerns	32
	FAA Has Several Efforts to Enhance Aviation Educational Outreach and Attracting Youth and Diversity to the Aviation Workforce	39
	Agency Comments	45
Appendix I: Labor Market Indicator Analysis		46
Appendix II: Aviation Industry Stakeholders Interviewed		50
Appendix III: Additional Information on Government and Industry Aviation Forecasts		51
Appendix IV: Additional Information on Changes Regarding the New Title 14 C.F.R. Part 147 Interim Final Regulations		54
Appendix V: GAO Contact and Staff Acknowledgments		58
Tables		
	Table 1: Unemployment, Employment, and Earnings for Selected Aviation Professions, 2017-2021	46
	Table 2: Aviation Industry Stakeholders Interviewed	50
Figures		
	Figure 1: Training Pathways to Become a Commercial Airline Pilot	7
	Text for Figure 1: Training Pathways to Become a Commercial Airline Pilot	8

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Figure 2: Paths to Federal Aviation Administration (FAA) Certification for Aircraft Mechanics	10
Text for Figure 2: Paths to Federal Aviation Administration (FAA) Certification for Aircraft Mechanics	10
Figure 3: Distribution of Active Airline Transport Pilot Certificates in 2022 by Age Group	14
Data for Figure 3: Distribution of Active Airline Transport Pilot Certificates in 2022 by Age Group	15
Figure 4: Applications from Foreign Pilots for Airline Transport Pilot Certifications, 2017–2022	34
Data for Figure 4: Applications from Foreign Pilots for Airline Transport Pilot Certifications, 2017–2022	34

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### Abbreviations

ACES	Aviation Career Education for Students
ACS	Airman Certification Standards
ALPA	Air Line Pilots Association
ATEC	Aviation Technician Education Council
ATP	Airline Transport Pilot
BLS	Bureau of Labor Statistics
DOT	Department of Transportation
FAA	Federal Aviation Administration
FAPA	Future and Active Pilot Advisors

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May 17, 2023

The Honorable Maria Cantwell  
Chair  
The Honorable Ted Cruz  
Ranking Member  
Committee on Commerce, Science, and Transportation  
United States Senate

The Honorable Sam Graves  
Chair  
The Honorable Rick Larsen  
Ranking Member  
Committee on Transportation and Infrastructure  
House of Representatives

Aviation is important to the movement of people and goods and is a critical sector of the U.S. economy. Like many other sectors of the economy, aviation has been adversely affected by the COVID-19 pandemic. Passenger demand for air travel plummeted in 2020, creating cascading effects across sectors including airlines, airports, and repair stations. However, this demand has steadily rebounded since spring 2021.<sup>1</sup> In 2023, traffic levels in North America are expected to exceed pre-pandemic traffic levels, according to a March 2022 forecast from the International Air Transport Association.<sup>2</sup> As a result, industry questions about whether it has sufficient workers to meet demand have reemerged. We have previously reported on concerns expressed by airlines that new workers—particularly commercial airline pilots and aircraft mechanics—are not entering the aviation industry at a pace sufficient to replace attrition and retirements and support the industry’s projected growth.<sup>3</sup> The

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<sup>1</sup>GAO, *COVID-19 Pandemic: Observations on the Ongoing Recovery of the Aviation Industry*, [GAO-22-104429](#) (Washington, D.C.: October 21, 2021).

<sup>2</sup>International Air Transport Association, *Air Passenger Numbers to Recover in 2024*, March 1, 2022.

<sup>3</sup>GAO, *Aviation Workforce: Current and Future Availability of Airline Pilots*, [GAO-14-232](#) (Washington, D.C.: Feb. 28, 2014), and *Current and Future Availability of Aviation Engineering and Maintenance Professionals*, [GAO-14-237](#) (Washington D.C.: Feb. 28, 2014).

aviation industry's response to the COVID-19 pandemic may have exacerbated these concerns, as airlines encouraged workers to retire or voluntarily separate to reduce costs during the industry downturn.

The FAA Reauthorization Act of 2018 includes a provision for us to study the aviation and aerospace workforce of the future, including the current and future supply of individuals in the workforce.<sup>4</sup> This report examines (1) what is known about the current supply of and demand for commercial airline pilots, and what is projected for the future; (2) what is known about the current supply of and demand for aircraft mechanics, and what is projected for the future; (3) challenges related to aviation workforce supply, according to industry stakeholders; (4) actions the aviation industry has taken to address any identified workforce supply concerns; and (5) the status of FAA's efforts to support the development of the aviation industry workforce.

To understand what is known about the supply of and demand for pilots<sup>5</sup> and aircraft mechanics<sup>6</sup>, we examined data on professional certifications and on students enrolled in training programs, as well as hiring and employment data for these occupations.<sup>7</sup> We analyzed employment data reported by airlines to the Department of Transportation (DOT) from 2017 through 2021—the most recent available at the time of our analysis. These data include information from the 22 domestic mainline and

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<sup>4</sup>Pub. L. No. 115-254, § 622, 132 Stat. 3186, 3404. We began this study in February 2019, but paused the work in 2020–2021 due to the COVID-19 pandemic's effects on the aviation industry.

<sup>5</sup>We focused on pilots who were employed by U.S. airlines providing scheduled passenger service. Other employers of pilots, which are outside of our scope, include aircraft operators such as air taxis and business jets that provide unscheduled, charter, and on-demand passenger service, and cargo airlines that operate aircraft configured specifically for carrying cargo.

<sup>6</sup>We focused on aircraft mechanics certificated by FAA to inspect, service, and repair aircraft. The aviation maintenance workforce also includes (1) repairmen, whose certification from FAA allows them to perform specific tasks such as welding or painting, but is valid only at the employer for which it was issued; and (2) aviation maintenance workers who are not certificated and are supervised by certificated mechanics or repairmen in performing repair work.

<sup>7</sup>For our analysis, we used a basic supply and demand framework, along with the interaction of changes in hiring, employment and wages using available data, to infer changes in supply and demand from 2017 through 2021.

regional airlines that carried 99 percent of U.S. passengers in 2020.<sup>8</sup> To examine the employment characteristics of pilots and aircraft mechanics—such as wages and unemployment—we analyzed Current Population Survey data from the Department of Labor’s Bureau of Labor Statistics (BLS) for selected labor market indicators from 2017 through 2021.<sup>9</sup> See appendix I for our labor market indicator analysis. We analyzed data on pilot hiring for the years 2017 through 2022 provided by Future and Active Pilot Advisors (FAPA), a career and financial advisory service for current and aspiring pilots. We determined the data were sufficiently reliable by conducting selected manual and electronic tests of the data.

In addition, we analyzed FAA data on new airline transport pilot and mechanic certificates issued from 2017 through 2022, as well as the total number of certificates FAA estimated to be active over that time frame; newly-issued certificates are a subset of that total number. To assess the reliability of the FAA data, we reviewed documentation related to these data sources from our prior reports and interviewed knowledgeable agency officials about the quality of the data. We determined the data were sufficiently reliable for our purposes. We also analyzed data provided by the University Aviation Association, a non-profit organization representing collegiate aviation programs, on student enrollment, school tuition, and mandatory lab fees at four-year collegiate aviation programs from 2017 through 2021. We determined the data were sufficiently reliable by conducting selected manual and electronic tests of the data.

To examine what is projected for the pilot and mechanic professions, we analyzed several government and private sector aviation forecasts. These

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<sup>8</sup>FAA defines mainline airlines as those providing service primarily via aircraft with 90 or more seats, and regional airlines as those providing service via aircraft with 89 or fewer seats and whose routes serve mainly as feeders to the mainline airlines. See FAA, *The Economic Impact of U.S. Civil Aviation: 2020*, August 2022. The 22 airlines we selected are Southwest Airlines, American Airlines, Delta Air Lines, United Airlines, Spirit Airlines, JetBlue, Alaska Airlines, Frontier Airlines, Allegiant Air, Hawaiian Airlines, Skywest Airlines, Republic Airways, Envoy Air, PSA Airlines, Endeavor Air, Mesa Airlines, Horizon Air, Piedmont Airlines, ExpressJet Airlines, Air Wisconsin Airlines, GoJet Airlines, and CommuteAir.

<sup>9</sup>Data from DOT and BLS are not comparable due to different data collection methods and coverage. DOT data are monthly full-time and part-time employment statistics that certain airlines are required to report to DOT. BLS data are collected through a survey of households, are subject to response and sampling error, and are not limited to airline employment. Airlines that operate at least one aircraft with the capacity to carry combined passengers, cargo, and fuel of 18,000 pounds are required to report these employment statistics to DOT.

forecasts were identified and selected based on our prior work on aviation workforce supply. We were not able to verify the underlying data that private sector organizations collected and used in developing their forecasts of future demand due to the data's proprietary nature. The forecasts are based on a variety of assumptions, and actual demand may differ from projected demand due to a variety of factors. However, the forecasts provide useful information on what might be expected for the future given the assumptions.

To identify aviation industry stakeholder perspectives on longer-term aviation workforce supply concerns, we conducted interviews with a non-generalizable sample of 25 aviation industry stakeholders. They included four passenger airlines; three collegiate flight schools; three aviation maintenance technician schools; three maintenance repair stations; two labor unions; two aviation consultants or academics; one aviation manufacturer; one flight training company; and six industry associations that represent various industry segments. See appendix II for the list of stakeholders interviewed. We selected these stakeholders to be reflective of regions of the country, size of operations, and different types of maintenance work performed. While this sample of stakeholders enabled us to learn about factors affecting the demand for and supply of pilots and mechanics, it was designed to provide anecdotal information, not findings that could be extrapolated to the entire aviation industry. We also held two discussion groups with a non-generalizable selection of currently-employed aircraft mechanics, identified with labor union assistance, in which we discussed their perspectives on their careers to that point, including what factors attracted them to aviation careers and what obstacles they have faced. We also reviewed our prior reports on aviation workforce and government and private sector reports on aviation workforce supply.

To identify the actions the aviation industry has taken to address workforce supply concerns, we conducted interviews with the non-generalizable sample of 25 aviation industry stakeholders identified above. We also reviewed trade publications and scholarly articles that identify actions the aviation industry has taken to address supply concerns. Further, we analyzed hourly pay rates offered to first-year pilots by selected airlines from 2017 through 2021 using data obtained from the Air Line Pilots Association, a pilot labor union. We determined these data were sufficiently reliable by conducting selected manual and electronic tests of the data. Finally, we reviewed airline and repair station corporate websites and industry trade press for examples of outreach programs.

To determine the status of FAA's efforts to support the development of the aviation industry workforce, we reviewed relevant federal laws and regulations and FAA documentation including grant applications and rulemaking documents. We also interviewed FAA program officials with subject matter expertise in areas such as pilot and mechanic certification and education and outreach programs.

We conducted this performance audit from November 2021 to May 2023 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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## Background

The aviation industry relies on a highly skilled workforce, which includes pilots to operate aircraft and aircraft mechanics to perform maintenance on aircraft. The supply of and demand for pilots and aircraft mechanics determines how many are employed and the wages they earn. For these occupations, supply refers to the current economy's ability to produce employable pilots and mechanics at a given wage rate, whereas demand refers to employers' desire to hire them at a given wage rate. The industry's demand for pilots and mechanics is driven by a number of factors including projected demand for air travel and the number of aircraft that airlines expect to use to fulfill that demand, as well as anticipated workforce attrition and retirements.

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## Airline Pilots

FAA is responsible for regulating the safety of civil aviation in the United States, including the administration of pilot certification (licensing) and safety oversight of pilot training. Regulations for initial pilot training and certification are found in two parts of the Federal Aviation Regulations: pilot training requirements<sup>10</sup> and requirements for obtaining a pilot school certificate.<sup>11</sup> Schools that provide pilot training include (1) collegiate aviation schools, (2) non-collegiate vocational pilot schools, and (3) non-collegiate, instructor-based pilot schools.<sup>12</sup> Collegiate aviation schools that provide initial pilot training typically offer a two- or four-year undergraduate degree in an aviation-based major along with the pilot certificates and ratings necessary to become a commercial pilot. All pilot schools must comply with FAA's pilot training requirements. However, some pilot schools may elect to obtain a pilot school certificate from FAA as well, for which schools are required to meet prescribed standards with respect to training equipment, facilities, student records, personnel, and curriculum. Non-collegiate, instructor-based schools can offer flexible training environments where the training sequence can be altered to meet specific students' needs and time commitments. Upon completion of training, students obtain pilot certificates by passing FAA's tests.

### **The Federal Aviation Administration's 1,500-Hour Requirement**

In July 2013, FAA began requiring all commercial airline first officers to have an ATP certificate, which requires 1,500 hours of flight experience. Pilots with fewer than 1,500 hours can obtain a "restricted-privileges" ATP certificate (R-ATP), under which specific academic training courses or military experience can reduce the hours of total flight time required to fly certain operations. FAA made this change following the 2009 Colgan Air Inc. crash in New York, and subsequent

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<sup>10</sup>14 C.F.R. Part 61. These requirements prescribe the minimum training, knowledge, and experience requirements for acquiring different types of pilot certificates and for becoming a flight instructor.

<sup>11</sup>14 C.F.R. Part 141. These regulations prescribe requirements for issuing pilot school certificates and the general operating rules applicable to a holder of the certificate.

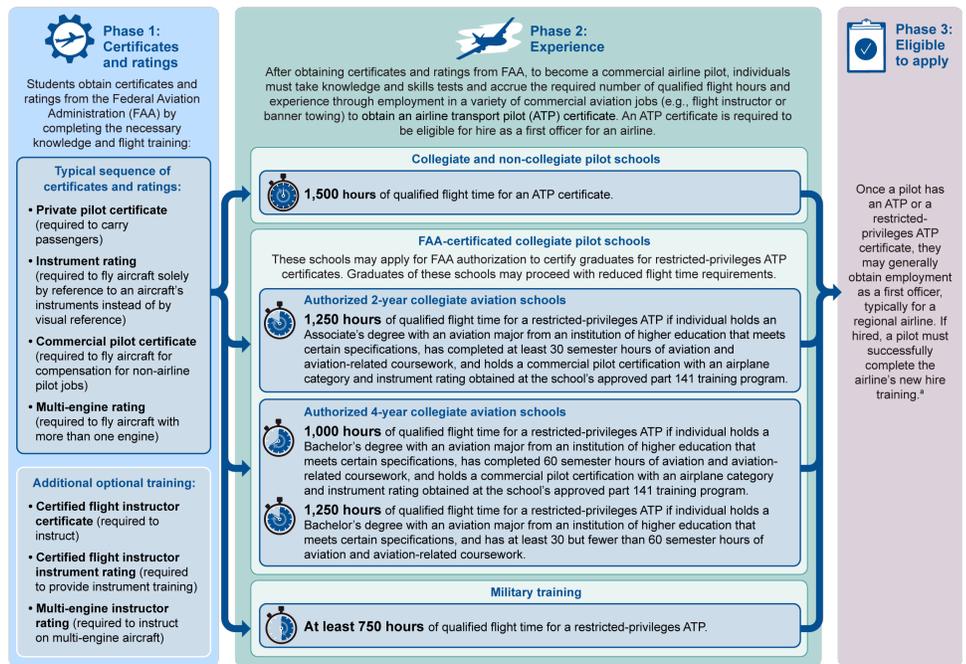
<sup>12</sup>Non-collegiate instructor-based schools can be either an individual for-hire flight instructor operating as a single-instructor school at a local airport, or a more traditional training school with a small physical facility located at a particular airport.

legislation that required FAA to modify, among other things, first officer qualifications. In our 2014 report, FAA and industry stakeholders estimated that it could take an additional 1 to 2 years for pilots coming out of school to meet the 1,500-hour requirement.

Source: GAO analysis of Federal Aviation Administration information. | GAO-23-105571

We have previously reported that meeting FAA’s certification and aeronautical experience qualifications to become an airline pilot requires years of training.<sup>13</sup> To become eligible for pilot training, prospective students generally must be cleared by a medical examination and obtain medical and student pilot certificates from FAA. Pilot students then begin training, acquiring the knowledge and flight training to obtain a private pilot certificate, instrument rating, commercial pilot certificate, and multi-engine rating (see fig. 1). To be eligible for hire as either a first officer or captain at an airline providing scheduled passenger air service, individuals must obtain an airline transport pilot (ATP) certificate in addition to other certifications and ratings. Obtaining an ATP certificate requires 1,500 hours of flight experience (see sidebar).

Figure 1: Training Pathways to Become a Commercial Airline Pilot



Source: GAO presentation of information contained in Part 61, Part 121, and Part 141 of Title 14 of the U.S. Code of Federal Regulations. | GAO-23-105571

<sup>13</sup>GAO-14-232.

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**Text for Figure 1: Training Pathways to Become a Commercial Airline Pilot**

**Phase 1: Certificates and ratings**

Students obtain certificates and ratings from the Federal Aviation Administration (FAA) by completing the necessary knowledge and flight training:

Typical sequence of certificates and ratings:

- Private pilot certificate (required to carry passengers)
- Instrument rating (required to fly aircraft solely by reference to an aircraft's instruments instead of by visual reference)
- Commercial pilot certificate (required to fly aircraft for compensation for non-airline pilot jobs)
- Multi-engine rating (required to fly aircraft with more than one engine)

Additional optional training:

- Certified flight instructor certificate (required to instruct)
- Certified flight instructor instrument rating (required to provide instrument training)
- Multi-engine instructor rating (required to instruct on multi-engine aircraft)

**Phase 2: Experience**

After obtaining certificates and ratings from FAA, to become a commercial airline pilot, individuals must take knowledge and skills tests and accrue the required number of qualified flight hours and experience through employment in a variety of commercial aviation jobs (e.g., flight instructor or banner towing) to obtain an airline transport pilot (ATP) certificate. An ATP certificate is required to be eligible for hire as a first officer for an airline.

**Collegiate and non-collegiate pilot schools**

1,500 hours of qualified flight time for an ATP certificate.<sup>a</sup>

**FAA-certificated collegiate pilot schools**

These schools may apply for FAA authorization to certify graduates for restricted-privileges ATP certificates. Graduates of these schools may proceed with reduced flight time requirements.

**Authorized 2-year collegiate aviation schools**

1,250 hours of qualified flight time for a restricted-privileges ATP if individual holds an Associate's degree with an aviation major from an institution of higher education that meets certain specifications, has completed at least 30 semester hours of aviation and aviation-related coursework, and holds a commercial pilot certification with an airplane category and instrument rating obtained at the school's approved part 141 training program.

**Authorized 4-year collegiate aviation schools**

1,000 hours of qualified flight time for a restricted-privileges ATP if individual holds a Bachelor's degree with an aviation major from an institution of higher education that meets certain specifications, has completed 60 semester hours of aviation and aviation-related coursework, and holds a commercial pilot certification with an airplane category and instrument rating obtained at the school's approved part 141 training program.

1,250 hours of qualified flight time for a restricted-privileges ATP if individual holds a Bachelor's degree with an aviation major from an institution of higher education that meets certain specifications, and has at least 30 but fewer than 60 semester hours of aviation and aviation-related coursework.

**Military Training**

At least 750 hours of qualified flight time for a restricted-privileges ATP.

**Phase 3: Eligible to apply**

Once a pilot has an ATP or a restricted-privileges ATP certificate, they may generally obtain employment as a first officer, typically for a regional airline. If hired, a pilot must successfully complete the airline's new hire training.

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Source: GAO presentation of information contained in Part 61, Part 121, and Part 141 of Title 14 of the U.S. Code of Federal Regulations. | GAO-23-105571

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<sup>9</sup>To serve as a pilot-in-command, a pilot may be required to meet additional experience requirements depending on the type of operation. For example, to serve as a pilot-in-command for regularly scheduled air carriers, a pilot must have an additional 1,000 hours experience performing certain operations.

Some airlines operate partnerships with pilot schools called bridge or pathway programs to attract pilots and better align pilot training with the airline's needs. In pathway programs, airlines and students at pilot schools enter into agreements that in some cases provide tuition assistance, and may provide mentorship and a conditional offer of employment with the airline once a student reaches a certain amount of flight experience. We have previously reported on the role these programs play in the pilot training and hiring pipeline, and airlines have expanded these programs in recent years.<sup>14</sup>

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## Aircraft Mechanics

The aviation maintenance workforce is typically employed by businesses including commercial airlines, corporate flight departments, aircraft repair stations, fixed base operators, manufacturers of aircraft or aircraft components, and other maintenance organizations that are not certificated as a repair station, manufacturer, or airline. Aircraft mechanics—one of several types of aviation maintenance workers—are certificated by FAA to inspect, service, and repair aircraft bodies (airframe) and engines (powerplant).<sup>15</sup> To become a certificated mechanic, an individual must meet certain experience requirements, which can take several years of education or training.

Individuals must pass three FAA mechanic tests—written, oral, and practical—to become certificated.<sup>16</sup> FAA publishes testing standards for

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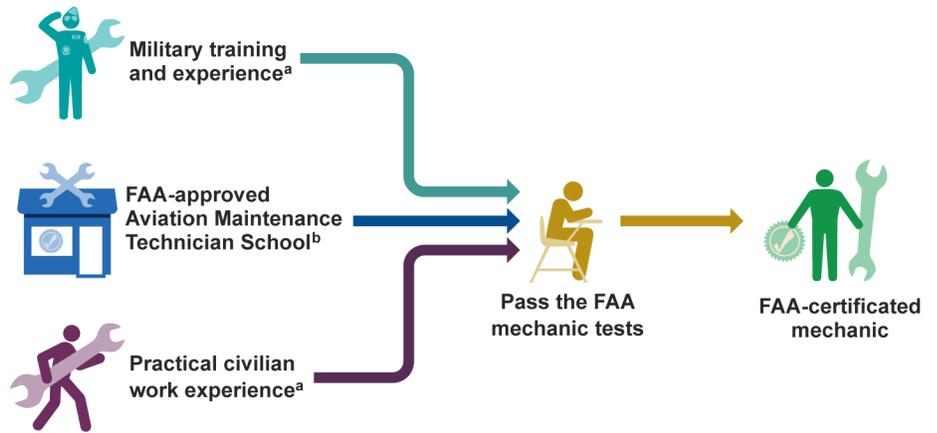
<sup>14</sup>[GAO-14-232](#).

<sup>15</sup>“Certificated” means that the individual has received a certificate, in this case from FAA. Other aviation maintenance workers are (1) repairmen, whose certification from FAA allows them to perform specific tasks such as welding or painting, but is valid only at the employer for which it was issued; and (2) aviation maintenance workers who are not certificated and are supervised by certificated mechanics or repairmen in performing repair work.

<sup>16</sup>The written knowledge test includes topics such as the construction and maintenance of aircraft, relevant FAA regulations, and basic maintenance principles. The oral and practical tests cover all of the technical and regulatory subject areas and test individuals on their technical skills.

the oral and practical skills tests. There are several paths an individual could follow to become eligible to take the tests (see fig. 2).<sup>17</sup>

**Figure 2: Paths to Federal Aviation Administration (FAA) Certification for Aircraft Mechanics**



Source: GAO analysis of FAA regulations and other FAA documents. | GAO-23-105571

**Text for Figure 2: Paths to Federal Aviation Administration (FAA) Certification for Aircraft Mechanics**

Military training and experience <sup>a</sup>		
FAA-approved Aviation Maintenance Technician School <sup>b</sup>	Pass the FAA mechanic tests	FAA-certificated mechanic
Practical civilian work experience <sup>a</sup>		

Source: GAO analysis of FAA regulations and other FAA documents. | GAO-23-105571

<sup>a</sup>FAA requires at least 18 months of practical aircraft maintenance experience for either the airframe or powerplant rating, and at least 30 months for both ratings. This experience could be civilian or military. Depending on an applicant's military specialty, FAA may grant credit for military aviation maintenance experience toward the airframe and/or powerplant ratings.

<sup>b</sup>The length of these programs varies between 1 and 2 years.

<sup>17</sup>14 C.F.R. § 65.75, 65.79.

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## Federal Assistance to the Aviation Industry during the Pandemic

The aviation industry received significant federal assistance to help mitigate the effects of the COVID-19 pandemic.<sup>18</sup> Among other assistance, COVID relief laws provided up to \$63 billion in financial assistance to passenger airlines and other eligible applicants to pay employee wages, salaries, and benefits.<sup>19</sup> Congress also provided up to \$3 billion through the Aviation Manufacturing Jobs Protection Program to eligible aviation manufacturing companies to pay up to half of the companies' compensation costs for certain categories of employees, for up to six months.<sup>20</sup> The financial assistance, depending on the program, required recipients to refrain from conducting involuntary furloughs, among other requirements.<sup>21</sup> However, accepting federal COVID-19 assistance did not preclude some actions that airlines and aviation businesses took to manage labor costs. For example, some airlines offered early retirements. In addition, many workers at least temporarily left the aviation industry during the pandemic, according to Airlines for America, an airline trade association. The association estimates that, based on a mix of public reports and information provided directly by airlines, approximately 50,000 airline employees opted for early retirement or voluntary separation in 2020, while 100,000 employees took unpaid leaves of absence.

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<sup>18</sup>We reported in 2021 that U.S. passenger traffic was down 60 percent system-wide in 2020 compared to 2019 traffic levels, according to DOT data. See [GAO-22-104429](#). The ripple effect from this unprecedented and sustained reduction in demand throughout 2020 affected airline business models, employment, and the aviation supply chain.

<sup>19</sup>We reported in April 2022 that the Department of Treasury has made \$59 billion in payments out of \$63 billion available to 405 passenger airlines, 256 contractors, and 38 cargo airlines. See GAO, *COVID-19: Current and Future Federal Preparedness Requires Fixes to Improve Health Data and Address Improper Payments*, [GAO-22-105397](#) (Washington, D.C.: April 27, 2022).

<sup>20</sup>We reported in April 2022 that DOT has offered over \$717 million to 596 eligible applicants. See [GAO-22-105397](#).

<sup>21</sup>For example, recipients were to use financial assistance from the three rounds of the Payroll Support Program (PSP) exclusively for the continuation of wages, salaries, and benefits. Recipients were required to refrain from conducting involuntary furloughs or terminations.

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## Pilot Supply Has Grown, and Demand for Pilots is Projected to Continue to Be Strong

Pilot supply grew from 2017 through 2022 based on certification and student enrollment data. Based on FAA’s forecast of ATP certificates, the number of ATP certificate holders under 65—the current mandatory retirement age for commercial passenger airline pilots—may increase over the next 20 years.<sup>22</sup> Current demand for pilots has been strong, based on trends in hiring, employment, and wages, and regional airlines reported that they have been affected by pilot shortfalls. Industry and government forecasts, which are dependent on a variety of underlying assumptions, project that demand for pilots could be strong in the future.

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## Pilot Supply Has Grown and May Increase Over the Next Two Decades

From 2017 through 2022, the supply of individuals qualified to be passenger airline pilots—those under 65 years old and holding both an airline transport pilot (ATP) and an active medical certificate—increased by about 3,000, according to FAA data. The number of new ATP certificates issued each year grew by more than 100 percent from 2017-2022. The number of individuals enrolled in pilot training schools has also grown in recent years. According to FAA’s forecast of ATP certificate growth, the number of ATP certificate holders under 65 may increase 10-17 percent from 2022 through 2042.

### Airline Transport Pilot Certificates

According to FAA data, between 2017 and 2022, the number of individuals under 65 holding both an ATP certificate and an active medical certificate increased by about 2 percent (144,557 to 147,934 certificates). This pool of ATP certificate holders may include persons who are unavailable for work or are not employed by airlines.<sup>23</sup> Data are

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<sup>22</sup>Federal Aviation Administration, *FAA Aerospace Forecast Fiscal Years 2022–2042* (2022).

<sup>23</sup>Individuals under the age of 65 who hold active ATP certificates but are not employed by airlines may also be serving as pilots in the U.S. military, employed as pilots in non-airline operations, employed by foreign airlines, employed in non-pilot jobs in the aviation industry, or working in non-aviation careers. Data were not available to determine or verify how many active ATP certificate holders were employed outside airlines.

not available to determine or verify how many ATP certificate holders are actively employed as airline pilots. The pandemic negatively affected the total number of ATP certificate holders. There were almost 1,700 fewer ATP certificates in 2020 compared to 2019, and in 2021, there were roughly 2,700 fewer certificates than in 2019. However, the number of ATP certificates in 2022 exceeded 2019 levels.

The number of new ATP certificates issued each year by FAA grew more than 100 percent between 2017 and 2022 (from 4,449 to 9,588 certificates per year). This is an annualized growth rate of roughly 16 percent per year.<sup>24</sup>

### Pilot Students

The number of individuals enrolled in pilot training schools—that is, potential future ATP certificate holders—has also grown in recent years. Our analysis of University Aviation Association data found that between 2017 and 2021, pilot student enrollment in aggregate increased 96 percent from 15,329 to 30,088 students.<sup>25</sup> In addition, faculty from three collegiate aviation programs told us their enrollment has increased in recent years, which they attributed to ongoing demand for pilots.

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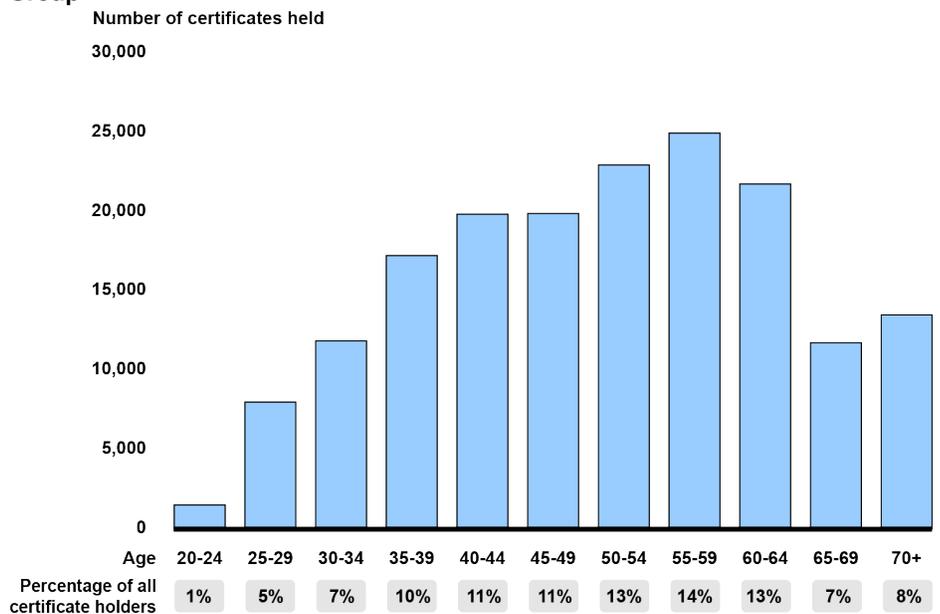
<sup>24</sup>New (also referred to as original) ATP certifications include those approved by FAA examiners and inspectors, as well as those issued without a test. According to FAA, individuals who comply with the special conditions listed within the Implementation Procedures for Licensing could be issued an ATP certificate without a test.

<sup>25</sup>A total of 97 private or public flight schools reported student enrollment data to the University Aviation Association in the 2017-2021 time period; however, the number of schools reporting in each year varied.

## Mandatory Pilot Retirements

The future supply of pilots is offset by those reaching age 65 who are no longer eligible to be employed as commercial airline pilots.<sup>26</sup> According to FAA data, the average pilot age has remained at roughly 51 years old from 2017 through 2022. Almost 15 percent of all ATP certificate holders (25, 214 of about 173,000) were 65 or older in 2022 (see fig. 3). According to FAA data, an average of about 4,300 ATP holders under 65 will reach mandatory retirement age each year from 2022 through 2042. Approximately 15 percent of current ATP certificate holders under 65 will turn 65 by 2027, 32 percent by 2032, 47 percent by 2037, and 61 percent by 2042. Other factors, such as early retirements or pilots leaving the aviation industry, could further reduce pilot supply; however, these data are not publicly available.

**Figure 3: Distribution of Active Airline Transport Pilot Certificates in 2022 by Age Group**



Source: GAO analysis of Federal Aviation Administration information. | GAO-23-105571

<sup>26</sup>ATP certificate holders 65 or older can serve as pilots for other types of aircraft, serve as flight instructors, and in other airline roles. Legislation introduced in March 2023 would raise the mandatory retirement age for commercial airline pilots from 65 to 67. Senate and House versions of the “Let Experienced Pilots Fly Act” legislation would also require pilots over the age of 60 to maintain a first-class medical certification that needs to be renewed every six months. S. 893, 118<sup>th</sup> Cong. (2023); H.R. 1761, 118<sup>th</sup> Cong. (2023).

**Data for Figure 3: Distribution of Active Airline Transport Pilot Certificates in 2022 by Age Group**

Age	Number of ATP Certificates Held	Percentage of certificates held
20-24	1496	1
25-29	7982	5
30-34	11846	7
35-39	17229	10
40-44	19842	11
45-49	19890	11
50-54	22949	13
55-59	24955	14
60-64	21745	13
65-69	11730	7
70+	13484	8

Source: GAO analysis of Federal Aviation Administration information. | GAO-23-105571

Note: Pilots age 65 and over are no longer eligible for employment with scheduled U.S. passenger airlines, but could work as pilots or instructors elsewhere.

Based on FAA’s forecast of ATP certificate growth, which, according to FAA officials, factors in mandatory retirements, the number of ATP certificate holders under 65 may increase over the next two decades.<sup>27</sup> To project the growth of ATP certificate holders who are under 65, according to FAA officials, an annual growth rate between 0.5 and 0.8 percent could be applied to the pool of certificate holders. Using those lower and upper bounds, the pool of certificate holders could grow from 147,934 in 2022 to either 163,452 (10 percent) or as many as 173,492 (17 percent) ATP certificate holders in 2042. However, the extent to which the projected supply would exceed or fall short of industry’s demand for pilots is unknown given the uncertainties surrounding future demand.<sup>28</sup>

<sup>27</sup>Federal Aviation Administration, *FAA Aerospace Forecast Fiscal Years 2022–2042* (2022).

<sup>28</sup>We have long reported that the demand for air travel is highly cyclical in relation to the state of the economy, as well as to political, international, and health-related events. See GAO, *Commercial Aviation: Airline Industry Contraction Due to Volatile Fuel Prices and Falling Demand Affects Airports, Passengers, and Federal Government Revenues*, [GAO-09-393](#) (Washington, D.C.: Apr. 21, 2009).

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## Current Demand for Pilots is Strong, and Forecasts Project Strong Demand Will Continue

Publicly available data on hiring and employment—and their interaction with wages—indicate there is strong current demand for pilots, and government and industry forecasts project that strong demand will continue in the future.

### Pilot Hiring

Pilot hiring, one of the key measures of demand for airline pilots, recovered strongly in 2021 following a steep drop after the onset of the pandemic. According to data from the pilot consultancy Future and Active Pilot Advisors (FAPA), nine U.S. mainline passenger airlines hired a total of 28,418 pilots from 2017 through 2022—an average of almost 4,700 pilots per year.<sup>29</sup> The FAPA data capture the total hires by the nine airlines and do not identify the extent to which these nine airlines were hiring pilots new to the labor force or pilots that were employed at or moving between the other airlines. However, representatives from two regional airlines told us that they have lost pilots to hiring by larger airlines in recent years. In addition, that growth was not evenly distributed across the period. For example, in 2020 those nine airlines collectively hired about 1,500 pilots, coinciding with the steep drop in demand for air travel early in the pandemic. In most cases, these airlines froze pilot hiring from April–December 2020. In 2021, these nine airlines hired 4,067 pilots, and in 2022 hired 11,194 pilots, according to FAPA data.

### Pilot Employment and Wages

The number of pilots employed by 22 mainline and regional U.S. airlines increased from 2017 through 2021, according to the latest full-year data reported by airlines to DOT available at the time of our analysis. From 2017 to 2019, employment increased from about 70,747 to 78,000 pilots. However, in 2020, pilot employment at those airlines dropped by almost 9 percent to 71,241, as many pilots retired, were furloughed, or left the profession, at least temporarily. According to the latest available data,

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<sup>29</sup>The nine mainline U.S. passenger airlines for which FAPA makes pilot hiring data publicly available are Alaska Airlines, Allegiant Air, American Airlines, Delta Air Lines, Frontier, Hawaiian Airlines, Southwest Airlines, Spirit Airlines, and United Airlines.

employment in 2021 remained at about 73,000 pilots, below 2018 levels.<sup>30</sup>

Mainline and regional airline first officer pay rose from 2017 through 2021, according to our analysis of pay data from the Air Line Pilots Association (ALPA), a pilot union. Across the 10 mainline airlines we selected, starting pay for a first officer in their first year rose from an average of about \$62 per hour in 2017 to almost \$76 per hour in 2021, an annualized rate of 5.3 percent.<sup>31</sup> Several pilot contracts covering 2022 included pay raises for pilots, according to ALPA data. For example, first officers at Frontier Airlines saw their pay increase from about \$60 to \$75 an hour in March 2022, and again to \$90 an hour in August 2022. Hourly pay for first officers at Hawaiian Airlines increased from \$36 to \$81 an hour in April 2022.

Regional airlines have also increased their starting pay for first officers since 2017, according to ALPA data. First-year, hourly pay for a first officer across the 12 selected regional airlines rose from an average of \$35 an hour in 2017 to almost \$45 an hour in 2021, an annualized growth rate of about 6 percent per year.<sup>32</sup> American Airlines implemented the most significant pay increases during this period at its wholly owned regional affiliates PSA, Piedmont, and Envoy, according to ALPA data. In

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<sup>30</sup>According to BLS data, employment of the aircraft pilots and flight engineers occupational group increased by about 0.7 percent per year from 2017 through 2021 (from 112,000 to 115,000). In comparison, employment across all occupations increased by about 0.2 percent each year according to BLS.

<sup>31</sup>In real 2021 dollars, pay rose from about \$68 per hour in 2017 to \$76 per hour in 2021, an annualized rate of 2.7 percent per year. We adjusted pay for inflation in real 2021 dollars using the Consumer Price Index from the U.S. Department of Labor, Bureau of Labor Statistics.

<sup>32</sup>In real 2021 dollars, pay rose from about \$39 an hour in 2017 to about \$44 an hour in 2021, an annualized rate of 3 percent per year. We adjusted pay for inflation in real 2021 dollars using the Consumer Price Index from the U.S. Department of Labor, Bureau of Labor Statistics.

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June 2019, for example, first-year, first officer pay at Envoy rose from \$26 to \$51 an hour.<sup>33</sup>

### Demand for Pilots at Regional Airlines

Demand for pilots is especially acute among regional airlines, which have lost pilots to other employers, according to representatives from regional airlines. For example, Mesa Airlines testified in May 2022 that it lost approximately five percent of its pilot workforce to other airlines and aircraft operators in April 2022.<sup>34</sup> Similarly, in July 2022, representatives from another regional airline told us they have lost about 100 pilots a month to larger airlines. One regional airline estimated that regional airlines would lose about 11,000 pilots—or 65 percent of their workforce—to larger airlines in 2022. Representatives from three regional airlines told us that they typically lose more experienced captains to mainline airlines, which creates a challenge for regional airlines in having sufficient captains to develop their less experienced first officers.<sup>35</sup> To become a captain, a first officer must complete an additional 1,000 flying hours in air carrier operations either while paired with a captain in the cockpit, or as pilot in command under certain other operations. Representatives from one regional airline told us that their first officers had fewer opportunities to accumulate those 1,000 flying hours in 2020

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<sup>33</sup>According to BLS data, median wages for the aircraft pilots and flight engineers occupational group, which includes more than airline pilots, decreased by an average of 0.1 percent per year from 2017-2021 (from \$1,919 to \$1,913 per week); however, they did not decrease in each year. The median wage in 2021 for this occupational group was \$134,630. We adjusted BLS wage data for inflation and express it in real 2021 dollars using the Consumer Price Index from the U.S. Department of Labor, Bureau of Labor Statistics.

<sup>34</sup>Jonathan G. Ornstein, Chairman and Chief Executive Officer of Mesa Air Group, *Field Hearing: Developing the Aviation Workforce of the 21st Century*, testimony before the Senate Committee on Commerce, Science, and Transportation Subcommittee on Aviation Safety, Operations, and Innovation, 117<sup>th</sup> Congress, 2<sup>nd</sup> sess., May 12, 2022.

<sup>35</sup>In commercial aviation, according to FAA regulations, the pilot-in-command (captain) of an aircraft is the person aboard the aircraft who is ultimately responsible for its operation and safety during all phases of flight, as well as when it is operating or moving on the ground. The second-in-command (first officer) is the second pilot of an aircraft, and has the authority to assume command of the aircraft in the event of incapacitation of the captain. However, control of the aircraft is normally shared equally between the captain and first officer during flight.

due to the overall reduced level of passenger air travel. Consequently, regional airlines may be struggling to fill captain vacancies.<sup>36</sup>

Pilot shortfalls at regional airlines have affected their service levels, according to two regional airlines and an industry association. For example, representatives from the two regional airlines said that, because they have too few pilots, they have been unable to meet their contractual flying obligations for their mainline airline partners. Representatives from one regional airline told us that, with full pilot staffing, they usually fly about 65,000 aircraft hours per month.<sup>37</sup> However, as of early July 2022, the airline was flying about 52,000–54,000 aircraft hours per month, according to representatives, an almost 20 percent decrease.

### Future Pilot Demand

The federal government and the aviation industry forecast that demand for pilots will continue to be strong in the future. For example, BLS projects an average of about 18,000 job openings annually until 2031 for the aircraft pilots and flight engineers occupational group, which is broader than airline pilots. While these forecasts are helpful in gaining a sense of aviation workforce demand in the years to come, developing forecasts is inherently difficult, as they are based on a variety of assumptions and actual demand might differ from projected demand due to a variety of factors. For example, the projections assume continued economic growth, but if a recession or another unexpected event like the COVID-19 pandemic were to occur, the projections of workforce demand are likely to be higher than actual demand. For additional information on government and industry forecasts, see appendix III.

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<sup>36</sup>We also found that labor market data from BLS for 2017 through 2021 (the latest available data at the time of our analysis) are inconclusive as to whether a labor shortage exists for the “aircraft pilots and flight engineers” occupational group, which includes commercial passenger and cargo airline pilots, charter pilots, flight instructors, and helicopter pilots, among other occupations. See appendix I for our labor market indicator analysis.

<sup>37</sup>We use “aircraft hours” to describe what the aviation industry calls “block hours.” Block hours are a common measure of aircraft usage that refer to the amount of time from the moment aircraft doors close at departure until they open at arrival.

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## Available Data Provide Limited Information on Aircraft Mechanic Supply and Demand

The supply of individuals with new mechanic certificates grew from 2017 through 2022. The total pool of mechanic certificates also increased; however, these data provide limited information about the supply of aircraft mechanics, as the number of certificate holders who have left the industry since 2017 is unknown.<sup>38</sup> Additionally, available data provide limited information on the extent of demand for aircraft mechanics. Nevertheless, aviation businesses we interviewed reported challenges maintaining a sufficient number of mechanics. Government and industry forecasts, which are dependent on a variety of underlying assumptions, project that demand for mechanics could be strong in the future.

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### Although New Mechanic Certificates Have Grown in Recent Years, Certification Data Provide Limited Information on Aircraft Mechanic Supply

#### Mechanic Certificates

The number of newly-issued mechanic certificates—representing the number of individuals who have recently obtained the license that qualifies them to be aircraft mechanics—increased 11 percent from 2017 through 2022 (6,398 to 7,119 certificates), an annualized growth rate of about 2 percent per year.<sup>39</sup> Issuance of new certificates increased each

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<sup>38</sup>In addition to aircraft mechanics, the aviation maintenance workforce includes repairmen, whose certification from FAA allows them to perform specific tasks such as welding or painting, but is valid only at the employer for which it was issued; and aviation maintenance workers who are not certificated and are supervised by certificated mechanics or repairmen in performing repair work.

<sup>39</sup>As mentioned earlier, new (also referred to as original) mechanic certifications include those approved by FAA examiners and inspectors, as well as those issued without a test.

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year from 2017 to 2019, but fell 29 percent in 2020, and remained below 2019 levels in 2022.<sup>40</sup>

The total pool of mechanic certificates, which includes the new certificates, also increased from 2017 to 2022 (by 12 percent, from 286,268 to 320,042 certificates—an annualized growth rate of about 2 percent per year). However, these data provide limited information on the current aircraft mechanic workforce, as the number of mechanic certificate holders who have retired from, or otherwise left, the aviation industry since 2017 is unknown. Additionally, as we reported in 2020, individuals holding mechanic certificates might never work in the aviation industry, or might begin their career in the aviation industry and leave for a job in another industry, and these data are not reported.<sup>41</sup> Additionally, there is no mandatory retirement age for aircraft mechanics (from which the number of certificate holders exiting the workforce over a period of time could be estimated), and the number of certificate holders who are deceased is not reported.

### Mechanic Student Enrollment

The enrollment of students in aviation maintenance technician (maintenance) schools—that is, potential future mechanic certificate holders—has increased slightly in recent years. According to survey data compiled by the Aviation Technician Education Council (ATEC), an association representing maintenance schools, estimated enrollment at maintenance schools from 2017 to 2021 rose from 17,791 students in 2017 to roughly 21,000 in 2021.<sup>42</sup> However, officials we spoke with from two maintenance schools indicated that their enrollments have either remained fairly steady or decreased in recent years. For example,

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<sup>40</sup>FAA officials said that the availability of testing during the pandemic is one reason for the decline in new pilot and mechanic certificates in 2020. FAA officials told us that the vendor the agency uses to administer pilot and mechanic exams encountered challenges in providing continued testing services during the pandemic. These officials said the challenges included ensuring that test centers were in compliance with local government and facility COVID-19-related mandates, and communicating information to the aviation community related to mandatory lockdowns and social distancing requirements at test centers. FAA officials said the requirements at test centers varied across nearly every county in the country.

<sup>41</sup>GAO, *Aviation Maintenance: Additional Coordination and Data Could Advance FAA Efforts to Promote a Robust, Diverse Workforce*, [GAO-20-206](#) (Washington, D.C.: Feb. 6, 2020).

<sup>42</sup>According to ATEC, between 172 and 188 schools responded to its survey each year from 2017 through 2021.

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officials from one school told us that before the pandemic they had a waiting list for enrollment, but now they are unable to fill all of their available seats.

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## Available Data Provide Limited Information about Current Demand for Mechanics, but Forecasts Suggest Strong Future Demand

### Current Mechanic Demand

Available data provide a limited picture of the extent of current demand for aircraft mechanics. Hiring data from repair stations and other aviation industry employers of aircraft mechanics are not publicly available, which limits visibility into the extent to which employers are trying to fill vacancies. Data reported to DOT by airlines indicate that employment of maintenance labor (a category that includes more than just aircraft mechanics) at 22 mainline and regional airlines decreased by about 11 percent (from 46,622 to 41,311 workers) from 2017 through 2021.<sup>43</sup> DOT data is limited to airlines, and does not include, for instance, employment at independent repair stations.<sup>44</sup> As we reported in 2016, airlines have moved more of their major maintenance to repair stations in recent years.<sup>45</sup>

However, average annual pay for maintenance labor at the 22 mainline and regional airlines increased by about 12 percent over this period,

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<sup>43</sup>DOT's "Maintenance Labor" category includes apprentice mechanics, carpenters, chief mechanics, cleaners, crew chiefs, electricians, engineers, foremen, inspectors, lead mechanics, mechanics, mechanic helpers, non-productive shop labor, and shop labor not identified with specific maintenance projects.

<sup>44</sup>According to BLS data, employment of the aircraft mechanics and service technicians occupational group decreased by about 0.2 percent per year from 2017 through 2021 (from 153,000 to 152,000). In comparison, employment across all occupations increased by about 0.2 percent each year, according to BLS.

<sup>45</sup>GAO, *Aviation Safety: FAA's Risk-Based Oversight for Repair Stations Could Benefit from Additional Airline Data and Performance Metrics*, [GAO-16-679](#) (Washington, D.C.: Sept. 2, 2016).

according to DOT data.<sup>46</sup> Across the 10 mainline airlines we selected, maintenance pay rose by an annualized rate of about 2 percent from roughly \$89,000 to \$98,000 per year over the five years.<sup>47</sup> At the 12 selected regional airlines, maintenance pay rose by an annualized rate of 3.6 percent from approximately \$59,000 to about \$68,500 annually.<sup>48</sup> Although other factors may be involved, the decline in airline employment coupled with an increase in wages suggests that there could be a decrease in the number of mechanics willing and able to work for airlines, due to retirements or to individuals finding employment elsewhere. Further, labor market data from BLS are inconclusive as to whether a labor shortage exists for the “aircraft mechanics and service technicians” occupational group.<sup>49</sup> See appendix I for our labor market indicator analysis.

Nevertheless, representatives from four airlines, three repair stations, and a labor union told us that aviation businesses have experienced challenges maintaining a sufficient number of mechanics. Representatives told us that an insufficient number of mechanics is contributing to backlogs in work and delays in maintenance activities. Representatives from one regional airline reported that it was 5-7 percent below its desired staffing level in April 2022, while representatives from another regional airline reported that their attrition has outpaced new hires over the prior 12 months. The consulting firm Oliver Wyman’s *Global Fleet and MRO Market Forecast 2022-2032* reports that aviation

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<sup>46</sup>According to BLS data, median wages for the aircraft mechanics and service technicians occupational group have decreased by an average of 0.2 percent per year since 2017 (\$1,292 to \$1,282 per week). The median wage in 2021 for this occupational group was \$65,380, according to BLS. We adjusted median wages for aircraft mechanics and service technicians for inflation in 2021 dollars using the Consumer Price Index.

<sup>47</sup>In real 2021 dollars, maintenance pay at mainline airlines decreased from nearly \$99,000 per year in 2017 to almost \$98,000 per year in 2021, an annualized rate of 0.2 percent per year. We adjusted pay for inflation in real 2021 dollars using the Consumer Price Index from the U.S. Department of Labor, Bureau of Labor Statistics.

<sup>48</sup>In real 2021 dollars, maintenance pay at regional airlines increased from almost \$66,000 per year in 2017 to \$68,500 per year in 2021, an annualized rate of 1 percent per year. We adjusted pay for inflation in real 2021 dollars using the Consumer Price Index from the U.S. Department of Labor, Bureau of Labor Statistics.

<sup>49</sup>The aircraft mechanics and service technicians occupational group includes occupations such as aircraft engine specialists, airframe mechanics, flight test mechanics, and helicopter engine mechanics.

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maintenance supply challenges in North America could limit the number of aircraft in service to meet passenger demand.<sup>50</sup>

### Future Mechanic Demand

The federal government and the aviation industry forecast that demand for aviation maintenance workers—including aircraft mechanics—may be strong in the future. For example, BLS projects an average of about 11,500 job openings annually for the aircraft mechanics and service technicians occupational group from 2021 until 2031. Similar to the pilot demand forecasts, these forecasts are helpful in gaining a sense of the demand for aircraft mechanics in the years to come, but are based on a variety of assumptions and actual demand might differ from projected demand due to a variety of factors, such as economic shocks or other factors that can affect growth in the aviation industry. For additional information on government and industry forecasts, see appendix III.

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## Selected Aviation Stakeholders Identified Continuing Challenges to Increasing the Supply of Pilots and Mechanics

Aviation industry stakeholders we interviewed identified a number of challenges to increasing the supply of pilots and mechanics, several of which we have previously reported. For example, stakeholders identified the cost of education and fewer former military pilots as challenges affecting pilot supply. For mechanics, stakeholders identified, among other factors, pay and working conditions and competition for talent from other industries as challenges. Stakeholders also noted that limited workforce diversity is affecting both pilot and mechanic supply.

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<sup>50</sup>Oliver Wyman, *Global Fleet and MRO Market Forecast 2022-2032* (2022). MRO is an acronym that stands for maintenance, repair, and overhaul organizations.

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## Selected Stakeholders Identified Pilot Education Costs, Certification Requirements, and Other Factors as Challenges to Increasing Pilot Supply

### Cost of Pilot Education

Several stakeholders, including faculty from three collegiate aviation programs, told us that the cost of education to become a pilot may be prohibitive for many students, including members of underrepresented groups, whose families may lack the resources to provide support. We have previously reported that the cost of a collegiate flight education is a challenge for some colleges in recruiting and retaining students.<sup>51</sup>

According to data from the University Aviation Association, the average cost of a four-year degree plus flight training “lab fees” in 2021 was \$85,745 for in-state students (\$13,768 per year on average) and \$138,511 for out-of-state students (\$20,656 per year on average).<sup>52</sup>

According to University Aviation Association data, the average cost of flight training in 2021 was \$55,887. As we have previously reported, flight training costs may vary, depending on the school requirements, student interest, and aptitude. Pilot program curriculums may differ and some students may choose to take additional classes. Each additional certificate and rating adds to the total cost of the training. In addition, the time required for students to complete certificates and ratings varies.

Further, the full cost of a collegiate flight education exceeds the maximum amount of certain types of federal student loans available to eligible students. For example, for academic years 2022-23, the maximum annual federal Pell Grant is \$6,895, and annual federal student loan limits for undergraduates range from \$5,500 up to \$12,500 depending on the student’s year in school, dependency status, and other factors. Most students need to either use family resources or take out private loans to pay for the total cost of a pilot program, as we reported in 2018. Not all students have the means to take out private loans, as private lenders may require a co-signer with good credit and a minimum income level.

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<sup>51</sup>GAO, *Collegiate Aviation Schools: Stakeholders’ Views on Challenges for Initial Pilot Training*, [GAO-18-403](#) (Washington, D.C.: May 15, 2018).

<sup>52</sup>Flight training lab fees include, among other things, the costs associated with obtaining private pilot certification, instrument rating, commercial pilot certification, flight instructor certification, and multi-engine rating.

There are lower cost alternatives to collegiate aviation schools, as we have reported previously, though they are not entirely equivalent. Students may obtain a flight education and achieve the same FAA certificates and ratings from a non-collegiate flight school and incur flight-training expenses without the added cost of college tuition.

### Airline Transport Pilot Certification Requirements

Aviation industry stakeholders we interviewed had differing views about the 1,500 flight-hour requirement for an individual to be eligible to be hired as a first officer and its effect on pilot supply. In addition to the cost of pilot education, representatives from two regional airlines identified the flight-hour requirement as a barrier to entry that has played a part in constraining the pilot labor pool and contributed to current pilot supply challenges. According to those representatives, the law that required FAA to increase the flight-hour requirement to earn an ATP certificate made it difficult for many people to pursue a pilot career. In 2018, regional airline association representatives similarly told us that the increased flight-hour requirement and several other factors were contributing to a tight labor market.<sup>53</sup> We reported that the increase in the number of flight hours required for a first officer may delay an individual's entry into the airline pilot profession, which may decrease the pool of eligible pilots that mainline and regional airlines can hire as a first officer.

The Air Line Pilots Association (ALPA) has stated that the 1,500-hour requirement has contributed to enhanced aviation safety and attributes the pilot supply challenges airlines have recently experienced to their decisions to implement workforce reductions in 2020.<sup>54</sup> ALPA has also stated that, based on the pool of ATP certificate holders, there is more than sufficient availability of qualified pilots to fly for airlines given the right opportunity. Additionally, faculty from the three collegiate aviation programs told us that the 1,500-hour requirement has had the benefit of helping schools retain flight instructors longer because their time instructing students counts toward the 1,500 hours. Absent the requirement, they said, many of their flight instructors would already have left to begin their pilot careers.

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<sup>53</sup>GAO-18-403.

<sup>54</sup>Air Line Pilots Association, "More Than Enough Pilots to Meet U.S. Airline Demand: Debunking the Pilot Shortage Myth," (McLean, Virginia: 2022), accessed July 29, 2022, <https://www.alpa.org/advocacy/pilot-supply>.

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### Infrastructure Constraints at Flight Schools

Faculty we interviewed from two collegiate aviation programs indicated that their ability to produce more pilots is constrained by existing school infrastructure, including facility and airspace limitations, and by the costs of the aircraft used to train students. These challenges are consistent with those we reported in 2018.<sup>55</sup>

- **Facility and airspace limitations:** Faculty from one school told us that limited classroom space, among other infrastructure constraints, has hampered its ability to take on additional enrollments, and the school is planning a new building to house the aviation program's administration as well as provide additional classrooms. Making effective use of limited available airspace, which may be constrained geographically, is also a challenge, according to faculty from another school.
- **Aircraft costs:** The aircraft that flight schools use to train students can be expensive to maintain, according to faculty from one school. They told us that it costs the school \$450,000 to maintain a Cessna 172, the most common training aircraft, and these costs have to be recouped from students. Faculty from the same flight school told us the program is using virtual reality flight simulator lab space to reduce the time and costs associated with flight training and more efficiently train the volume of enrolled students.

### Fewer Former Military Pilots

Representatives from a major airline, an industry association, and FAA told us that the military is the source of fewer pilots for airlines than in the past. We reported in 2014 that an estimated 70 percent of airline pilots hired prior to 2001 were military-trained.<sup>56</sup> In 2018, we reported that representatives from an airline pilots' association estimated that former military pilots make up about half of new hires at larger mainline airlines and about 30 percent of new hires at low-cost mainline airlines and

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<sup>55</sup>[GAO-18-403](#).

<sup>56</sup>[GAO-14-232](#).

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regional airlines.<sup>57</sup> Additionally, the military faces its own pilot shortfall, and in response, has implemented measures to better retain pilots.<sup>58</sup>

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## Selected Stakeholders Identified Pay, Competition, and Other Factors as Challenges to Increasing Mechanic Supply

Aviation industry stakeholders we interviewed identified pay and working conditions, awareness of the career path, competition for talent from other industries, and the curriculum requirements for maintenance schools as challenges to attracting more mechanics into the aviation sector.

### Pay and Working Conditions

Pay and working conditions may discourage some people from aircraft mechanic careers, according to stakeholders we interviewed. According to FAA officials, mechanics are often underpaid given the responsibilities they have for ensuring the safety and airworthiness of an aircraft. Additionally, several participants in our mechanic discussion groups noted working conditions including the likelihood of working the overnight shift early in one's career, working outside in inclement weather, and regular exposure to noise and chemicals. Participants also noted that the physical nature of the job can result in injuries, such as rotator cuff, hand, or knee issues, that require surgery toward the end of one's career.

### Limited Awareness and Understanding of Aviation Maintenance Careers

Several aviation industry stakeholders told us that interest in aircraft mechanic and other aviation maintenance careers suffers from a lack of public awareness and understanding of the career opportunities.

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<sup>57</sup>GAO, *Military Personnel: Collecting Additional Data Could Enhance Pilot Retention Efforts*, [GAO-18-439](#) (Washington, D.C.: June 21, 2018).

<sup>58</sup>According to a 2019 Department of Defense report to Congress, the military services have experienced a shortfall of at least 3,000 pilots across all of the service branches. For example, the Air Force reported it was short 2,000 pilots across its active and reserve components out of a total of 18,400 pilots at the end of 2018. The military services have employed several strategies to mitigate this shortfall, including changes to career tracks and compensation incentives. See Department of Defense, Office of the Under Secretary of Defense for Personnel and Readiness, *Report to Congressional Armed Services Committees on Initiatives for Mitigating Military Pilot Shortfalls*, (Washington, D.C.: January 16, 2019).

According to FAA officials, mechanics are not as visible to the public as other careers in the aviation industry. According to representatives from one regional airline, support mechanisms for promoting aviation maintenance professions—such as engagement with high schools and maintenance schools, promotional marketing, and recruitment—are not as well developed as those supporting and promoting the airline pilot profession. In addition, a participant in our mechanic discussion groups said that schools and employers need to better communicate the technical and computer-oriented aspects of being a mechanic, which he believed would attract more young people to the field. He said that the “grease monkey stigma” surrounding trade school and blue-collar work can deter young people from the profession. Similarly, officials from a repair station told us that high school administrators and guidance counselors push students toward careers that require four-year degrees and place less focus on pursuing technical and trade skills.

### Competition for Talent from Other Industries

According to several aviation stakeholders, the set of skills mechanics acquire from maintenance schools is valued by other industries, which may offer more attractive compensation or work environments than the aviation industry. We have previously reported that mechanics have relevant skills for working at a variety of occupations, including on oil rigs or at amusement parks.<sup>59</sup> The aviation industry downturn during the pandemic may have prompted some students to seek employment in other industries. According to a survey of students at maintenance schools included in the ATEC Pipeline Report 2021, 23 percent of survey respondents took jobs outside of aviation in 2020, a 15 percent increase from two years earlier. However, according to the ATEC Pipeline Report 2022, nearly all of the 47 percent of graduates from maintenance schools that received a job offer upon graduation were placed in aviation jobs.

### Curriculum Requirements for Maintenance Schools

Two stakeholders told us that the ability of maintenance schools to produce a supply of graduates prepared for modern aircraft technologies has been hampered, in part, by outdated curriculum requirements set in regulation. We reported in 2020 that curriculum requirements for maintenance schools were outdated and have remained largely

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<sup>59</sup>[GAO-14-237](#).

unchanged for several decades despite numerous attempts to update them as aviation technology has evolved.<sup>60</sup> In that review, FAA officials, employers, and maintenance school officials noted that the curriculum requirements do not emphasize commonly used aircraft technologies, such as avionics and composite materials. Similarly, while conducting this review, representatives from a repair station and a regional airline told us the curriculum requirements have left graduates to some extent unprepared for the work environment. However, mechanics in one of our discussion groups told us that although maintenance schools could incorporate newer technology, their education prepared them to be resourceful in investigating potential maintenance issues on aircraft.

In response to this issue, the Aircraft Certification, Safety, and Accountability Act, enacted in December 2020, included language directing FAA to issue new interim final regulations for aviation maintenance training.<sup>61</sup> In May 2022, FAA issued interim final regulations that replace prescriptive requirements for—among other things—curriculum, classroom hours, and proficiency standards for specific subjects with performance based standards, which are intended to be more flexible.<sup>62</sup> For example, aviation maintenance technician schools are no longer required to obtain FAA approval for changes to curriculum, but schools must ensure their curriculum aligns with the FAA's Mechanic General, Airframe, and Powerplant Airman Certification Standards, which will be used as the testing standard for the written, oral, and practical tests for mechanic certification beginning in July 2023.<sup>63</sup> See appendix IV for additional information on the interim final regulations.

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<sup>60</sup>[GAO-20-206](#).

<sup>61</sup>Pub. L. No. 116-260, div. V § 135, 134 Stat. 2309, 2356 (2020).

<sup>62</sup>The interim final rule generally went into effect on September 21, 2022. The interim final rule's new knowledge and skill requirements are to become effective August 1, 2023. 87 Fed. Reg. 31391 (May 24, 2022).

<sup>63</sup>The Mechanic General, Airframe, and Powerplant Airman Certification Standards (ACS) will replace the General, Airframe, and Powerplant Practical Test Standards, which established the standards for the oral and practical tests required to obtain a mechanic certificate with airframe and/or powerplant ratings. According to FAA, the ACS forms a more comprehensive standard for what an applicant needs to know, consider, and do in order to pass the oral and practical tests for a certificate or rating.

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## Selected Stakeholders Also Identified Limited Aviation Workforce Diversity as a Challenge to Increasing Pilot and Mechanic Supply

Some stakeholders we interviewed, along with an aviation industry workforce study, cited the underrepresentation of women and minorities in aviation careers as a factor limiting the labor supply of pilots and mechanics.<sup>64</sup> Although women represent 47 percent of the total U.S. workforce, 5 percent of pilots are women, and 3.6 percent of captains who are members of the Air Line Pilots Association are women, according to the study. The study also noted that racial and ethnic groups including Black or African American, Asian, and Hispanic or Latino persons are underrepresented in these careers. For example, officials from a non-profit pilot association told us that 3-5 percent of the pilot workforce are Latino. Additionally, data on pilot students in four-year schools provided by the University Aviation Association indicate that 17 and 29 percent of the 30,088 enrolled students in 2021 identify as female or minority, respectively. Women make up 2.6 percent of the aviation maintenance workforce, according to the study.

While these data offer some insight into the diversity of the workforce, we and others have identified opportunities for FAA to improve its data on the aviation maintenance workforce. In February 2020, we recommended that FAA use its existing data—which includes demographic information for certificate holders—and coordinate with other federal agencies to identify and gather information needed to measure progress and gather resources toward diversifying the talent pool for aviation maintenance careers.<sup>65</sup> Additionally, the FAA’s Women in Aviation Advisory Board report recommended that FAA expand its data to include gender data for all certification categories, with the ability to disaggregate by race and ethnicity, in order to better understand the number of women employed and in leadership positions in the aviation industry.<sup>66</sup> As noted later in the report, FAA is considering next steps on this recommendation.

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<sup>64</sup>Rebecca Lutte, *Women in Aviation: A Workforce Report, 2021 Edition* (Omaha, Nebraska: The University of Nebraska at Omaha Aviation Institute, December 2021).

<sup>65</sup>[GAO-20-206](#). As of May 2023, this recommendation remains open.

<sup>66</sup>Women in Aviation Advisory Board, *Breaking Barriers for Women in Aviation: Flight Plan for the Future* (Washington, D.C.: April 2022).

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## Aviation Businesses are Taking Various Actions to Address Workforce Supply Concerns

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### Airlines are Pursuing Actions to Address Pilot Supply Concerns

In an effort to address pilot supply concerns, U.S. airlines are: (1) offering higher pay and bonuses, (2) recruiting foreign pilots, (3) exploring regulatory flexibilities to use pilots that have not yet met the 1,500 flight-hour requirement for certain operations, and (3) starting their own flight schools.<sup>67</sup>

#### Offering Higher Pay and Bonuses

As demand for air travel rebounded, regional and mainline airlines increased pay and bonuses in 2022 to attract and retain pilots. In particular, several regional airlines have raised pay substantially to respond to increased pilot attrition to mainline airlines. For example, American Airlines' regional affiliates PSA, Piedmont, and Envoy announced in June 2022 that regional pilots will get a 73 percent pay increase from about \$52 to \$90 per hour until August 2024, after which their pay drops to \$64 per hour.<sup>68</sup> Other regional airlines have in turn increased pilot pay. In August 2022, CommuteAir, a regional airline that is partially owned by United Airlines, announced that it is increasing starting pay for first officers from \$51 an hour to \$72 an hour, and for captains from \$84 per hour to \$100 per hour. Mesa Airlines also announced in August 2022 that it would begin offering starting wages of \$100 an hour for first-year first officers, and \$150 an hour for first-year captains, increases of 118 percent and 172 percent, respectively.

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<sup>67</sup>Airlines might also pursue regulatory and operational flexibilities related to the pilot flight hours required discussed earlier. Specifically, Republic Airways sought an exemption—denied by FAA in 2022—that would allow pilot trainees who complete a tailored ATP training program at its LIFT Academy pilot training school to become eligible to fly for the airline after completing 750 hours in the cockpit, the number of flying hours at which military pilots qualify for a restricted-privileges ATP, which allows them to serve as a first officer until the necessary 1,500 hours are obtained.

<sup>68</sup>Specifically, first officers for the three regional airlines will see first-year pay for a first officer starting at \$90 an hour, up from \$51, while first-year captains will earn \$146 an hour, up from \$78.

Regional airlines are also offering signing bonuses, captain upgrade bonuses, and retention bonuses. For example, Envoy Air offers a \$15,000 signing bonus to new pilots and up to \$150,000 in pilot bonuses through its Pilot Retention and Bonus Program. Envoy Air officials told us that the airline started this program in an effort to retain more experienced first officers and address personnel imbalances when it began to lose many of its captains to higher-paying mainline airlines.

Mainline airlines have also increased pilot pay. For example, in October 2022, Alaska Airlines announced that it had ratified an agreement with the Air Line Pilots Association that offers pilot pay increases ranging from 8 percent to 23 percent, based on seniority. By 2024, captains will be earning \$300 to \$330 per hour and first officers \$108 to \$228 per hour, depending on years of service. Additionally, in March 2023, Delta Air Lines pilots approved a new contract that would provide pay raises of more than 30 percent over four years.

### Recruiting Foreign Pilots

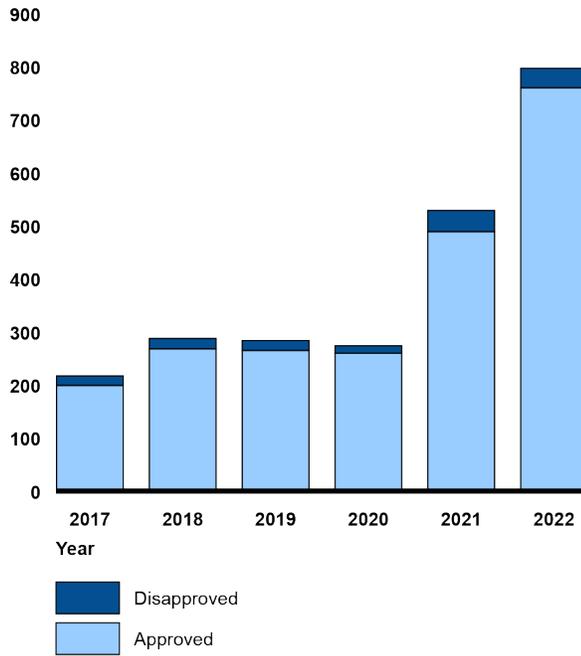
Airline interest in recruiting foreign pilots to bolster supply increased throughout the pandemic recovery in 2021 and 2022, based on FAA data. FAA data indicate that the number of foreign-licensed pilots seeking ATP certificates remained fairly steady from 2017 to 2020 before dramatically increasing during 2021 and 2022. The number of ATP applications from foreign pilots increased from 274 in 2020 to 797 in 2022, an increase of 191 percent.<sup>69</sup> The approval rate of these applications fluctuated slightly throughout this period, but remained relatively consistent, ranging from 92 to 95 percent of applications being approved (see fig. 4). However, foreign pilots remain a small portion of the pilot workforce.

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<sup>69</sup>We received data on applications from foreign pilots for ATP certificates from FAA on August 29, 2022, and therefore the application data do not account for the entire calendar year. According to FAA officials, the agency expected to receive 1,084 applications by the end of December 2022.

**Figure 4: Applications from Foreign Pilots for Airline Transport Pilot Certifications, 2017–2022**

Number of airline transport pilot certificate applications



Source: GAO analysis of Federal Aviation Administration information. | GAO-23-105571

**Data for Figure 4: Applications from Foreign Pilots for Airline Transport Pilot Certifications, 2017–2022**

	Approved ATP Applications	Disapproved ATP Applications
<b>2017</b>	199	18
<b>2018</b>	268	20
<b>2019</b>	265	19
<b>2020</b>	260	14
<b>2021</b>	489	40
<b>2022</b>	760	37

Source: GAO analysis of Federal Aviation Administration information. | GAO-23-105571

Several regional and low-cost U.S. airlines—including Breeze Airways, SkyWest Airlines, ExpressJet Airlines, CommuteAir, Spirit Airlines, and Frontier Airlines—have recruited and hired Australian pilots to address workforce concerns during the pandemic recovery.

The Air Line Pilots Association opposes the use of visa programs to recruit foreign pilots, arguing that U.S. airlines misuse these programs to avoid market pressures and suppress pilot pay rates. In June 2022, citing

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Spirit Airlines, the pilot union called on the Department of Homeland Security not to classify airline pilots as a “specialty occupation” that qualifies under the E-3 visa program.<sup>70</sup>

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## Seeking Greater Regulatory and Operational Flexibilities Related to Pilot Flight Hours

Two regional airlines have pursued regulatory strategies—one of which has been denied by FAA—to increase pilot supply. These strategies involve (1) an alternative pathway for pilots to earn an ATP certificate or (2) operating under circumstances in which first officers are not required to hold ATP certificates.

- **Alternative pathway to ATP certificate—Republic Airways:** In September 2022, the FAA denied Republic Airways’ request for exemption from ATP certification requirements. Republic sought an exemption that would allow pilot trainees who complete a tailored ATP training program at its LIFT Academy pilot training school to become eligible to fly for the airline after completing 750 hours in the cockpit. Republic noted that this is the same number of flying hours at which military pilots qualify for a restricted-privileges ATP, which allows them to serve as a first officer until they obtain the necessary 1,500 hours. Republic officials told us that pilots who are trained at LIFT Academy receive structured and thorough flight training that prepares them for airline flying conditions better than the unstructured flying pilots could otherwise use to accrue the 1,500 hours of flight time required for an ATP. However, the FAA found that LIFT Academy’s training program is not equivalent to the rigorous and comprehensive training reflected in military training, and determined that it should not be granted an exemption. Additionally, according to FAA, alternative pathways to allowing credit beyond what is currently in regulation must be accomplished through rulemaking.
- **Operating circumstances that do not require first officers to have an ATP certificate—SkyWest Charter:** SkyWest Airlines created a subsidiary airline “SkyWest Charter,” and in June 2022 filed a petition with the Department of Transportation (DOT) for authority to conduct charter operations, which only require a Part 135 certificate, in an

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<sup>70</sup>Joseph G DePete and Ryan Muller, *Joseph G DePete and Ryan Muller to Secretary of Homeland Security, June 23, 2022*. Letter. From Air Line Pilots Association, accessed November 4, 2022. <https://www.alpa.org>.

effort to maintain service to communities and markets it described as underserved.<sup>71</sup> Part 135 certificates authorize on-demand, unscheduled air service typical of smaller passenger planes (up to 30 seats) and cargo service. According to FAA, many Part 135 operators offer passenger and cargo service to remote areas. Under a Part 135 certificate, captains must hold an ATP certificate, but first officers do not have to meet the 1,500-hour requirement. As of May 2023, SkyWest Charter’s proposal remains under DOT review.

### Starting Flight Schools

United Airlines and Republic Airways launched flight schools in recent years to directly train their pilots and supplement their hiring pipelines.<sup>72</sup> These schools may also help students to address the cost of education by offering tuition reimbursement and other benefits. For example, once students in United Airlines’ Aviate Academy have completed their formal training, they must work toward pilot certification and have the option to either serve as a certified flight instructor at Aviate Academy or work at one of Aviate’s partner flight universities, flight schools, and Part 135 operators. Upon earning their ATP certificate, pilots work at one of the regional airlines operating as United Express (including Air Wisconsin, CommuteAir, GoJet, and Mesa Airlines) to gain flight experience until they qualify to transition to working at United Airlines. United Aviate Academy expects to train roughly 500 students annually, aiming to train 5,000 new pilots by 2030.

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## Aviation Maintenance Stakeholders are Working to Attract and Retain Mechanics

In response to hiring challenges discussed earlier, aviation maintenance stakeholders, including airlines and repair stations, cited actions they are

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<sup>71</sup>Part 135 certificates authorize on-demand, unscheduled air service typical of smaller passenger planes (up to 30 seats) and cargo service. According to FAA, many Part 135 operators offer passenger and cargo service to remote areas and provide a network to move cargo to larger Part 121 carriers.

<sup>72</sup>These flight schools replicate “ab initio” (a Latin term meaning “from the beginning”) training programs that are prevalent in Europe and represent a shift in the pilot training model in the United States. Ab initio programs are airline sponsored training programs that train individuals with no flight experience until they are a professional airline pilot. We have previously reported that ab initio programs have been used by some European airlines for years, while the United States previously only utilized ab initio principles at four-year universities. See GAO, *Initial Pilot Training: Better Management Controls Are Needed to Improve FAA Oversight*, [GAO-12-117](#) (Washington, D.C.: November 15, 2011).

taking to bolster the supply of mechanics. These actions include increasing pay, enhancing pathway and apprenticeship programs, and piloting aviation maintenance curriculum in high schools.

### Increasing Pay

According to several sources, employers have modestly increased mechanic wages in the last two years, but consumer price inflation may have counteracted more recent pay increases. ATEC reported in its 2022 Pipeline Report that the hourly wage for an entry-level certificated mechanic rose from \$21.54 in 2020 to \$25.49 in 2022, an 18 percent increase and above the rate of inflation for that period.<sup>73</sup> Additionally, officials from two repair stations we interviewed told us they had increased their wages for entry-level mechanics. ATEC reported that the overall median hourly wage for aircraft mechanics and technicians—both certificated and non-certificated mechanics at various points in their career—increased from \$30.32 in 2020 to \$31.52 in 2022, a roughly 4 percent increase.<sup>74</sup> According to Oliver Wyman’s 2022 MRO survey, roughly a third of the 150 aviation professionals surveyed (which include airlines, repair stations, and manufacturers) stated that they had increased overall wages by 5 percent or more from 2021 to 2022.<sup>75</sup> However, the rate of inflation from January 2021 to January 2022 was 7.5 percent, which indicates that the wage increases employers have implemented may have been offset by the reduction in consumer purchasing power resulting from consumer price inflation.

### Maintaining Pathway and Apprenticeship Programs

Airlines and repair stations use pathway programs and apprenticeships to recruit and hire entry-level maintenance workers.<sup>76</sup>

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<sup>73</sup>Aviation Technician Education Council (ATEC), *2022 Pipeline Report* (2022).

<sup>74</sup>ATEC, *2022 Pipeline Report* (2022).

<sup>75</sup>Oliver Wyman, *The Quest for Stability*.

<sup>76</sup>Pathway programs involve recruiting current students at maintenance schools for employment after they graduate and pass the FAA mechanic certification tests to limit the number of graduates taking employment in other industries. In apprenticeship programs, employers hire workers without aviation maintenance experience or with limited such experience and provide on-the-job training to prepare them to pass the FAA certification tests, often with a condition of employment once they have achieved their certification.

- **Pathway programs:** Some airlines and repair stations use pathway programs with maintenance schools and universities to attract and retain entry-level mechanics, offer them employment upon graduation, and advance them throughout their career. For example, in 2019 Endeavor Air (regional airline) launched its Aviation Maintenance Pathway program, which is now offered to students at 21 partner schools. Representatives from Endeavor visit partner schools to recruit students. Interested students submit an employment application to Endeavor six months before graduation, interview with Endeavor representatives at on-site events, and if accepted receive a conditional job offer before graduation. After mechanics have worked at Endeavor for 18 months, they qualify to apply for the Regional Pathway Employee program, which guarantees Endeavor mechanics an interview with Delta Air Lines.
- **Apprenticeship programs:** Two of the three repair stations we interviewed indicated that they had recently established apprenticeship programs to attract entry-level maintenance workers. Relatedly, a survey of 160 aviation professionals from airlines, repair stations, and manufacturers, conducted by Oliver Wyman, found that apprentice programs are the most effective way to attract and retain talent, with 60 percent of respondents responding that apprenticeship programs are very effective or extremely effective.<sup>77</sup>

### Piloting Maintenance Curriculum in High Schools

An industry-driven initiative called Choose Aerospace developed an aviation maintenance curriculum for raising awareness of aviation maintenance careers among high school students and assisting them on a pathway to obtaining mechanic certification.<sup>78</sup> Officials from ATEC, which is part of the initiative, told us that one of the primary goals of the program is to allow high school students to be exposed to aviation maintenance career paths, get an early start on their education, and be able to transfer course credit to FAA-approved maintenance schools. As of September 2022, 17 high schools and approximately 580 students are utilizing the Choose Aerospace curriculum.

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<sup>77</sup>Oliver Wyman, *Recover and Rebuild Toward a Leaner, More Agile MRO Industry* (2021).

<sup>78</sup>According to the Choose Aerospace web site, the initiative is a coalition of aviation maintenance stakeholders including industry, academic, and government representatives. The advisory committee includes representatives from a wide range of aviation industry stakeholders. Accessed May 2, 2023. <https://www.chooseaerospace.org/>.

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In February 2022, FAA rejected Choose Aerospace’s exemption request to allow students holding a certificate of completion of its curriculum to take the mechanic certification test without holding a graduation certificate from an FAA-approved maintenance school. FAA stated that because it lacks general oversight over the educational institutions that would use the curriculum, it would not be possible for FAA to provide the necessary oversight of schools’ administration of the curriculum for providing an equivalent level of knowledge or quality of instruction as a school.<sup>79</sup> Despite FAA’s decision, Choose Aerospace continues to offer curriculum and scholarships to expose students to aviation maintenance with the goal of enrolling 10,000 students by 2027.

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## FAA Has Several Efforts to Enhance Aviation Educational Outreach and Attracting Youth and Diversity to the Aviation Workforce

FAA has undertaken several efforts to enhance aviation educational outreach and to attract more youth and greater diversity to aviation careers. Some of the initiatives, such as studies on increasing youth and women’s awareness of and involvement in aviation and grants to help develop the aviation workforce, are in response to requirements in the FAA Reauthorization Act of 2018. Others, such as enhancements to FAA’s aviation education and outreach program, are agency-initiated. FAA is taking some initial steps to gauge the effects of these efforts.

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### FAA Has a Plan to Enhance Its Aviation Education and Outreach Program

FAA has a plan to enhance its aviation education and outreach program—the Science, Technology, Engineering, and Math Aviation and Space Education (STEM AVSED) program—which it has used for decades to expose students to aviation and aerospace careers and to promote STEM education. According to FAA, STEM AVSED aims to inspire youth from diverse backgrounds to pursue aerospace careers, and

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<sup>79</sup>Under current FAA regulation, there are three pathways to become eligible to take the written aviation mechanic exam: (1) military training and experience; (2) practical civilian work experience; and (3) education from an FAA-approved maintenance school.

to create a consistent pipeline of professionals for a robust aerospace workforce of the future.<sup>80</sup>

In January 2021, FAA completed the STEM AVSED Action Plan, which identifies four overall strategic goals for fiscal years 2021-2024, key objectives associated with each goal, implementation strategies for each objective, and associated data metrics. The four strategic goals are: (1) Pipelines and Pathways to Aerospace Careers; (2) STEM for Every Student; (3) Strategic Partnerships to Maximize the Benefits; and (4) Cross-Agency STEM Collaboration to Optimize the Program. The Action Plan noted that additional resources, such as for program staff, training, and collaborative efforts with external partners would allow the program to reach its strategic goals. FAA's FY 2023 budget submission included a request for \$2.9 million for staff and support that FAA stated would allow STEM AVSED to put more emphasis on outreach and engagement centered on emerging technologies. However, according to FAA officials, the funding increase was not appropriated by Congress.<sup>81</sup>

Officials from FAA told us that FAA currently does not have the data to evaluate the extent to which STEM AVSED participants go on to pursue aviation or aerospace careers, but is working on developing such data. According to FAA officials, a lack of available longitudinal data on students' progression through the educational system limits FAA's evaluative methods.<sup>82</sup> The officials told us that FAA is currently investing in a registration system that will allow FAA to gather more robust data on whether students are continuing to participate in FAA-sponsored aviation-related activities. Such a mechanism could help FAA monitor STEM AVSED efforts.

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<sup>80</sup>According to FAA, STEM AVSED offers learning opportunities to elementary, middle, and high school students to encourage young people to pursue careers in aviation. Partnering with key stakeholders in government, industry, and academia, STEM AVSED supports a variety of outreach activities including career fairs, career days, facility tours, job shadowing, and science fairs.

<sup>81</sup>Federal Aviation Administration, *Budget Estimates Fiscal Year 2023*.

<sup>82</sup>Longitudinal data are data that are collected sequentially from the same respondents over time.

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## FAA's Studies on Youth and Women Involvement in Aviation Identified Opportunities to Improve Government and Industry Efforts

In response to mandates in the FAA Reauthorization Act of 2018, FAA has established two organizational bodies that have undertaken studies and developed reports and recommendations focused on understanding existing FAA student outreach and encouraging youth and women's involvement in aviation careers.<sup>83</sup> FAA is determining how the recommendations from these efforts could be implemented.

### Recommendations from the Youth Access to American Jobs in Aviation Task Force

In October 2019, FAA established the Youth Access to American Jobs in Aviation Task Force (Task Force) in response to a mandate in Section 602 of the FAA Reauthorization Act of 2018.<sup>84</sup>

In September 2022, the Task Force released its report, which provides 21 recommendations in four categories to Congress, FAA, and the aviation industry. An example of a recommendation in each of the four categories is given below:

- **Early Awareness and Engagement:** Industry stakeholders should sponsor student competitions to support and create exciting, awareness-building aviation and aerospace competitions for middle and high school students.
- **Information Access:** One entity—whether government, private, non-profit, or a partnership with an existing platform—should create a one-stop aviation/aerospace information portal to provide information

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<sup>83</sup>In addition to responding to these efforts, FAA wrote the *Section 601 Youth in Aviation Outreach Report* summarizing its existing outreach efforts to students who are interested in STEM careers, as required in Section 601 of the FAA Reauthorization Act of 2018. Federal Aviation Administration, *Section 601 Youth in Aviation Outreach Report* (Washington, D.C.: January 2019). Pub. L. No.115-254, § 601, 132 Stat. 3185, 3400.

<sup>84</sup>The Task Force was directed to provide recommendations to FAA on how to facilitate and encourage students to pursue aviation education and job training programs, and identify and develop pathways to apprenticeships, work development programs, or careers in aviation. The Task Force was required to be comprised of representatives from air carriers, aviation manufacturers, aircraft repair stations, local educational agencies/high schools, institutions of higher education, and other aviation and educational stakeholders.

about aviation/aerospace careers and pathways on a centralized website.

- **Collaboration:** Representatives from industry, government, and education should form advisory councils at the regional levels—based on the nine FAA regions—for better coordination, communication, and partnership opportunities.
- **Overcoming the Financial Hurdle:** Aviation and aerospace companies could consider several different financial options—including assisting with repayment of student and training loans—to assist in bringing underrepresented groups to the sector.

#### Recommendations from the Women in Aviation Advisory Board

FAA established the Women in Aviation Advisory Board (Board) in May 2020 in response to a mandate in section 612 of the FAA Reauthorization Act of 2018.<sup>85</sup> The report issued by the Board in March 2022 provides, among other things, 55 recommendations to DOT, FAA, Congress, and the aviation industry on how to address barriers to recruiting, retaining, and advancing women in aviation.

The recommendations fall into five categories. These categories are noted below with an example of a recommendation for each:

- **Culture:** FAA should establish a campaign to raise awareness of and coordinate efforts of the many non-profit organizations that emphasize the introduction to and advancement of women in aviation professions.
- **Recruitment:** FAA and industry should collaborate to create a “one stop shop” virtual resource center for students, teachers, and aviation volunteers to streamline access to information about opportunities and pathways into aviation professions.
- **Retention:** Aviation organizations should provide parental leave associated with the birth and/or adoption of a child at 100 percent of an employee’s pay rate, and paid family leave, to care for an ill family member.
- **Advancement:** FAA should provide resources for industry organizations with documented professional development programs

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<sup>85</sup>The Board’s mandated objective was to develop and provide a plan for strategies that FAA can take to promote opportunities that encourage female students and aviators to pursue a career in aviation.

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for women and regularly publish a list of these resources on the virtual resource center.

- **Data:** Industry should adopt the best practice of tracking and publicly reporting the number of women in aviation occupations and leadership positions to include race/ethnicity and occupation level to better identify the number of women employed and in leadership positions.

In response, in December 2022, FAA officials said that individual FAA offices will be responsible for determining how recommendations that fall within their area of responsibility can be implemented. The agency plans to provide updates annually on the status of those recommendations via FAA's webpage for each effort.

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## FAA is Awarding Grants Aimed at Attracting Young People to Aviation Careers

FAA has begun awarding grants under its Aviation Workforce Development Grant Program, which is aimed at investing in the aviation workforce by helping to support the education and recruitment of the next generation of aviation professionals. The program was mandated by section 625 of the FAA Reauthorization Act of 2018, which required FAA to establish separate grant programs for pilots and aviation maintenance workers—Aviation Workforce Development Grants for Aircraft Pilots and Aviation Maintenance Technical Workers. According to FAA, the intent of the grant program for pilots is to support meaningful education designed to help students become aircraft pilots, aerospace engineers, or drone operators. The goal of the aviation maintenance grant program is to expand the aviation maintenance workforce, establish education and apprenticeship opportunities, and support activities to facilitate the transition to careers in aviation maintenance, including members of the Armed Forces. The law outlined dollar amount limits, eligibility requirements, and the authorization period for grant projects.<sup>86</sup>

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<sup>86</sup>According to section 625 of the FAA Reauthorization Act of 2018, each grant program is permitted to award \$5,000,000 each fiscal year, from 2019 to 2023. Each grant project is eligible to receive up to \$500,000 per fiscal year. The Aviation Workforce Development grant program has been authorized through fiscal year 2023.

**Example Aircraft Pilots Grant Project: Florida State College at Jacksonville**

FAA awarded \$498,000 to Florida State College at Jacksonville to implement the Aviation Career Education for Students (ACES) program, designed to provide aviation education and exposure to high school students. ACES curriculum will center on topics including aerodynamics, interpreting aeronautical charts and weather reports, and flight planning. The program plans to provide flight simulators, virtual reality materials, and mini drones for hands-on learning opportunities. Students will also attend field trips to local airports and “discovery flights,” where students can serve as co-pilot in a flight with an FAA-certified flight instructor. The ACES program will also offer professional development to participating teachers. The program plans to register 330 students.

Source: GAO analysis of grant proposal and grant award. | GAO-23-105571

**Example Aviation Maintenance Technical Workers Grant Project: Macon County School System**

FAA awarded \$425,000 to the Macon County School System in Tuskegee, Alabama, to implement a dual enrollment program targeting high school students, called the “Training Tuskegee Technicians” program, between Macon County School System and Red Tail Flight Academy. Upon completion of the Training Tuskegee Technicians program, students would be eligible to take the FAA general knowledge test and enter into the workforce as an entry-level line service technician assisting certified aircraft mechanics or continue into additional post-secondary training working toward airframe or power plant certification. The program plans to enroll 25 students each year.

Source: GAO analysis of grant proposal and grant award. | GAO-23-105571

In its initial round of funding in fiscal year 2022, FAA received more than 300 applications in total for the two programs. The agency awarded \$5 million in funding to 16 recipients under the grant program for pilots. Additionally, FAA awarded \$5 million to 15 recipients under the aviation maintenance grant program.<sup>87</sup> Examples of projects funded may be found in the sidebars.

The period of performance for each current recipient is 18 months, ending in July 2023. Upon project conclusion, recipients are required to submit grant closeout reports that document all progress and performance metrics.<sup>88</sup> FAA announced a second round of grant funding in April 2022, for which applications were accepted until June 2022.

Several stakeholders we interviewed—including officials from a labor union, a repair station, and an airline—indicated support for the Aviation Workforce Development Grant Program. However, these stakeholders expressed concerns about the amount of funding provided. For example, officials from one airline told us that the current funding provided for the program was likely not large enough to make a substantial impact.

FAA officials described challenges with implementing and maintaining the grant program. They explained that FAA’s Office of NextGen, the office responsible for managing the grant program, was not appropriated additional funds to administer the grant program, such as funding for grants officers, support personnel, subject matter experts to assist in the evaluation process, and a grants management system. According to FAA officials, they requested and received congressional authority and funding for program management for fiscal year 2023.

<sup>87</sup>Eligible applicants include holders of a certificate issued under parts 21, 121, 135, or 145 of Title 14 C.F.R., or labor organizations representing aviation maintenance workers, accredited higher education or high schools, and state or local government entities.

<sup>88</sup>Recipients are required to submit several indicators to FAA semi-annually to allow FAA to track the performance of grant projects, including: (1) a detailed description of program activities and recruitment events; (2) the number of individuals who enrolled in the program; (3) the number of individuals who successfully completed the program; and (4) the number of participants who successfully completed application or certification requirements necessary to become a pilot or aviation maintenance technical worker.

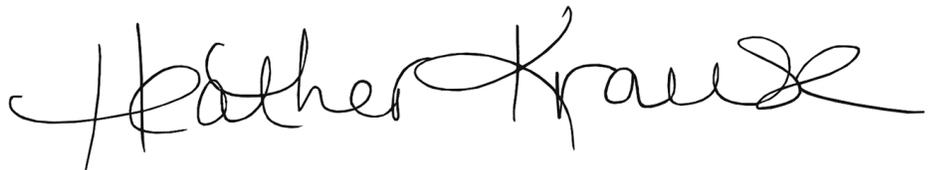
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## Agency Comments

We provided a copy of this report to DOT for review and comment. DOT provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Transportation, and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact Heather Krause at (202) 512-2834 or [krauseh@gao.gov](mailto:krauseh@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix V.

A handwritten signature in black ink that reads "Heather Krause". The signature is fluid and cursive, with the first letter of each word being capitalized and larger than the others.

Heather Krause  
Director, Physical Infrastructure Issues

# Appendix I: Labor Market Indicator Analysis

We have previously reported that the Bureau of Labor Statistics’ (BLS) labor market data are inconclusive as to whether labor shortages exist among airline pilots and aircraft mechanics.<sup>1</sup> From an economic perspective, while no single metric can be used to say whether a labor shortage exists, it is possible to examine certain labor market “indicators” in conjunction with the views of stakeholders. Specifically, we previously found that according to economic literature, if a job shortage were to exist, one would expect (1) a low unemployment rate signaling limited availability of workers in that profession, (2) increases in employment due to increases in demand for that occupation, and (3) increases in wages offered to draw people into that profession. Table 1 shows these specific indicators from 2017 through 2021, the latest available data at the time of our analysis, measured using the BLS’ Current Population Survey.

**Table 1: Unemployment, Employment, and Earnings for Selected Aviation Professions, 2017-2021**

	Annual percent change in median wages <sup>a</sup>	Annual percent change in employment <sup>b</sup>	Average unemployment <sup>c</sup>
Aircraft pilots and flight engineers	-0.1%	0.7%	3.1
Aircraft mechanics and service technicians	-0.2%	-0.2%	2.8
Overall	1.2%	0.2%	5.1

Source: GAO Analysis of Bureau of Labor Statistics’ Current Population Survey Data. | GAO-23-105571

<sup>a</sup>We calculated the “annual percent change in median wages” as the annualized percent change in median weekly earnings among full time wage and salary workers in that occupation (the midpoint between the highest 50 percent paid and the lowest 50 percent paid in that occupation). The changes in median wages were adjusted for inflation using the Consumer Price Index for all urban consumers.

<sup>b</sup>We calculated the “annual percent change in employment” as the annualized percent change in employment among full time workers in that occupation over the period.

<sup>c</sup>The unemployment rate is the percentage of persons aged 16 years or older that have no employment, but are seeking employment, out of the entire labor force. The unemployment rate for an occupation includes those unemployed in that occupation based on their most recent job. We

<sup>1</sup>GAO, *Military Personnel: Strategy Needed to Improve Retention of Experienced Air Force Aircraft Maintainers*, [GAO-19-160](#) (Washington, D.C.: Feb. 5, 2019), and [GAO-14-232](#).

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**Appendix I: Labor Market Indicator Analysis**

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calculated “average unemployment” by summing the unemployment levels over the period divided by the sum of the labor force over the period.

As table 1 indicates, while the direction of two of these indicators (change in employment and unemployment rates) is consistent with difficulty in hiring the “aircraft pilots and flight engineers” occupational group, one indicator (the change in wages) is not. While the direction of one of these indicators (unemployment rates) is consistent with difficulty in hiring the “aircraft mechanics and service technicians” occupational group, two indicators are not (the change in employment and wages). Thus, it is unclear whether a labor shortage exists for these two occupational groups based on these indicators. In addition, the indicators should be viewed with appropriate caveats, as described below:

- From 2017 to 2021, median wages for aircraft pilots and flight engineers decreased by about 0.1 percent per year. For aircraft mechanics and service technicians, wages decreased by about 0.2 percent per year. For all occupations, wages have increased by about 1.2 percent per year over this period. However, while median wages decreased in 2017 compared to 2021 for both occupations, they did not decrease in every year—and they exhibited increases of as much as 9 percent.<sup>2</sup>
- From 2017 to 2021, the average unemployment rate for aircraft pilots and flight engineers has been approximately 3.1 percent on average and for aircraft mechanics and service technicians it has been approximately 2.8 percent on average. In comparison, for all occupations, the unemployment rate has averaged about 5.1 percent.
- From 2017 to 2021, employment for aircraft pilots and flight engineers increased by about 0.7 percent per year. For aircraft mechanics and service technicians, employment decreased by about 0.2 percent per year. In comparison, for all occupations, employment has increased by about 0.2 percent per year over this period. However, while employment for aircraft pilots and flight engineers increased in 2017 compared to 2021, it did not increase in every year, and it exhibited

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<sup>2</sup>Given the fluctuations from year to year, we also estimated growth by averaging the year-to-year percentage changes. Looking at the average year-to-year changes, median wages for aircraft pilots and flight engineers did not change. For aircraft mechanics and service technicians, the average year-to-year change in median wages was .1 percent. For all occupations, the average year-to-year change in median wages was 1.3 percent.

decreases of as much as 12.5 percent.<sup>3</sup> Similarly, while employment for aircraft mechanics and service technicians decreased in 2017 compared to 2021, it did not decrease in every year— and it exhibited increases of as much as 1.3 percent.

We previously reported on important limitations to these indicators as measured using the Current Population Survey data.<sup>4</sup> These data are collected through a household survey and are subject to response and sampling error. Moreover, BLS collects information on workers at all stages in their career—so it may not be informative of changes in starting salaries—and the reported figures for aircraft mechanics include both certificated and non-certificated workers. As a result, labor market data may overestimate the number of available certificated mechanics for certain employers.

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<sup>3</sup>Given the fluctuations from year to year, we also estimated growth by averaging the year-to-year percentage changes. Looking at the average year-to-year changes, employment for aircraft pilots and flight engineers increased by 1.4 percent. For aircraft mechanics and service technicians, the average year-to-year change employment was -.2 percent. For all occupations, the average year-to-year change in employment was .3 percent.

<sup>4</sup>[GAO-14-232](#) and [GAO-14-237](#).

## Appendix II: Aviation Industry Stakeholders Interviewed

**Table 2: Aviation Industry Stakeholders Interviewed**

<b>U.S. federal agencies</b>	Federal Aviation Administration
<b>Industry associations</b>	Aeronautical Repair Station Association
	Airlines for America
	Aviation Technician Education Council
	Flight School Association of North America
	Latino Pilots Association
	Regional Airline Association
<b>Labor organizations</b>	Air Line Pilots Association
	Aircraft Mechanics Fraternal Association
<b>Aviation manufacturers</b>	Boeing
<b>Flight training companies</b>	CAE
<b>Passenger airlines</b>	Alaska Airlines
	Envoy Air
	Republic Airways
	SkyWest Airlines
<b>Repair stations</b>	Air Services Incorporated
	Aviation Technical Services
	FEAM Aero
<b>Aviation maintenance technician schools</b>	Aviation Institute of Maintenance
	Everett Community College
	Federal Aerospace Institute
<b>Collegiate flight schools</b>	Auburn University
	Embry-Riddle Aeronautical University
	University of North Dakota
<b>Academics and consultants</b>	Mike Boyd, President of Boyd Group International
	Rebecca Lutte, Associate Professor for the Aviation Institute, University of Nebraska Omaha

Source: GAO. | GAO-23-105571

# Appendix III: Additional Information on Government and Industry Aviation Forecasts

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## Government Forecasts

### Bureau of Labor Statistics (BLS)

BLS projects a 6 percent increase in employment from 2021 to 2031 within the occupational group “aircraft pilots and flight engineers”, which is roughly as much of an increase as the average expected growth for all occupations over the same time period.<sup>1</sup> This occupational group is broader than airline pilots and includes charter pilots, flight instructors, and helicopter pilots, among other occupations. BLS has projected employment growth as demand for business and leisure travel recover from the pandemic.<sup>2</sup> BLS projects an average of about 18,000 job openings annually until 2031 in this category, many of which can be

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<sup>1</sup>Projections are estimates of future job growth based on a series of modeling assumptions. As with any projections, the projections for individual occupations are subject to error because of the many unknown factors that may affect the economy over the projection period. Thus, due to a variety of factors, actual changes in employment might differ from projected changes.

<sup>2</sup>The COVID-19 pandemic triggered an economic recession from February to April 2020, which led to substantial and immediate declines in output and employment during that period. While the recession only lasted a few months, the pandemic persisted through 2021, continuing to disrupt economic activity, prevent or discourage individuals from re-entering the labor force, and impact other economic conditions that affect employment. The economy rebounded in 2021, regaining approximately 4.6 million jobs; however, this equates to only about half of the jobs that were lost from 2019 to 2020. As a result, the 2021 average employment level, which forms the baseline for the 2021–31 projections, remained well below pre-pandemic levels. Employment in a majority of sectors continued to recover through the first half of 2022, and the 2021–31 projections do not reflect the employment recovery and reallocation that occurred during that time period. Some industries that have been disproportionately affected by the COVID-19 pandemic have lower base-year values and are expected to experience cyclical recoveries in the early part of the 2021–31 decade, as industry output and employment normalize and return to their long-term growth trends, leading to higher projected employment growth. Projected rapid growth for industries in which employment fell in 2020 and remained low in 2021 also is expected to result in strong growth for the occupations employed by those industries. Thus, the 2021-2031 projections represent both short term adjustments to the pandemic as well as long term structural changes.

attributed to the need to replace workers who transfer to different occupations or leave the labor force. For the occupational group “aircraft mechanics and service technicians,” BLS projects an average of about 12,000 openings per year over the same period, many of which can be attributed to the need to replace workers who leave the field or retire. BLS projects employment within this group to grow by 8,000 (6 percent) from 2021 to 2031. BLS attributes the projected employment growth to a gradual increase in air traffic, which will require more workers to maintain a growing number of aircraft.

### Federal Aviation Administration (FAA)

FAA forecasts that from 2021 through 2042, airline transport pilot (ATP) certificate holders will increase by 18.5 percent from 163,934 to 194,300, a 0.8 percent increase each year.<sup>3</sup> According to FAA, the growth rate of ATP certificates is in line with the growth of the commercial and general aviation fleet that would employ the majority of these pilots. FAA officials said that although they do not project demand for pilots beyond a forecast of commercial jets and general aviation aircraft, forecasted growth in ATPs could be understood as a reasonable proxy for projected demand for pilots.

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## Industry Forecasts

Similar to the government forecasts, industry forecasts are based on a variety of assumptions and actual demand might differ from projected demand due to a variety of factors.

### Boeing

In its *Pilot and Technician Outlook 2022-2041* report, Boeing projects that from 2022 to 2041 airlines will need to hire 128,000 new pilots and 130,000 new aviation maintenance technicians<sup>4</sup> in North America—an average of 6,400 pilots and 6,500 technicians per year—to meet industry demand.<sup>5</sup> According to Boeing, its forecast may vary from year to year as a result of factors including regulatory changes, crew productivity, and

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<sup>3</sup>Federal Aviation Administration, *FAA Aerospace Forecast Fiscal Years 2022–2042* (2022).

<sup>4</sup>Boeing’s forecast is broader than FAA-certificated aircraft mechanics.

<sup>5</sup>Boeing, *Pilot and Technician Outlook 2022-2041* (2022).

aircraft mix. Similar to the 2021 edition of Boeing's Outlook and in contrast to earlier versions, Boeing's 2022 forecast excludes business aviation and civil helicopter activity. Boeing states that its forecast is based on the assumption that demand for air travel will recover to 2019 levels by 2024, and that industry will continue to invest in an uninterrupted pipeline of qualified personnel to replace those who either reached retirement age or opted for voluntary early retirement during the pandemic.

### CAE

In 2020, CAE, a worldwide provider of aviation training products, forecasted that 65,000 new airline pilots will be needed in the United States and Canada by 2029. Officials from CAE told us their forecast methodology takes into account data including projected demand for air travel, aircraft orders from airlines, information from subject matter experts, and discussions with airlines to forecast expected pilot retirement and attrition. Officials told us one of the limitations of their forecast is the challenge of predicting the next downturn, and its effect on workforce demand, in an industry that goes through boom and bust cycles. Officials explained that they prefer to use a 10-year forecast in order to be in better control of the data and produce more accurate calculations.

# Appendix IV: Additional Information on Changes Regarding the New Title 14 C.F.R. Part 147 Interim Final Regulations

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## New 14 C.F.R. Part 147 Interim Final Regulations

The Aircraft Certification, Safety, and Accountability Act, enacted in December 2020, included language directing the Federal Aviation Administration (FAA) to replace Part 147 of title 14, Code of Federal Regulations, among other regulatory provisions, with interim final regulations with mostly statutorily prescribed language. In May 2022, FAA issued an interim final rule that changes several prescriptive requirements affecting the way FAA provides oversight to aviation maintenance technician (maintenance) schools.

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## Curriculum

The prior regulation required a maintenance school to obtain FAA approval for its curriculum. The prior regulation also had prescriptive requirements for school curriculum with minimum-required classroom hours and level of proficiency for specific subjects that students were required to fulfill. The interim final rule eliminates these requirements, and instead requires schools to align their curriculum with standards in the FAA's Aviation Mechanic General, Airframe, and Powerplant Airman Certification Standards (ACS). Under the interim final regulations, FAA intends to create a more flexible performance-based standard for curriculum, which a maintenance school can meet in multiple ways.<sup>1</sup> Although the curriculum no longer requires its approval, according to FAA officials, FAA will still review the curriculum for compliance with the regulations as a part of its oversight responsibilities. For example, in its application for a Part 147 certificate a school must describe the manner in

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<sup>1</sup>Performance-based regulations specify required results but do not prescribe any specific method for achieving the required results.

which its curriculum will ensure students have the knowledge and skills necessary to be prepared to test for a mechanic certificate and associated ratings. According to officials, FAA will review the school's curriculum periodically to ensure it aligns with the ACS. FAA also plans to periodically observe instruction at the school in order to observe the school's delivery of the curriculum, including content, quality of instruction, and appropriate facilities, equipment, and materials used during curriculum delivery.

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### **Facilities, materials, and equipment**

The interim final regulations are also less specific than the previous regulations in the requirements for facilities, materials, and equipment used by maintenance schools. Instead of specific required items, the school must assure the appropriateness of the materials for the curriculum it intends to use. According to the interim final regulations, FAA's process for assessing the appropriateness of proposed facilities, materials, and equipment will not change, and FAA will base its assessments on the curriculum the school intends to use.

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### **Instructors**

The interim final regulations' requirements for school instructors are similar to the prior regulation, requiring each instructor to either hold an appropriate FAA mechanic certificate or be otherwise specially qualified to teach their assigned content. The student-to-instructor ratio also remains unchanged at 25:1 for any shop class. However, in one change, any qualified instructor can now count towards the student-to-instructor ratio, whereas previously the regulation required the one instructor for the 25:1 ratio to be FAA certificated. The regulations now also require that qualified instructors teach in a manner that ensures achievement of positive educational outcomes.

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### **Quality control**

In response to a statutory requirement established by the Aircraft Certification, Safety, and Accountability Act, the interim final rule requires a school to 1) establish and maintain a quality control system to monitor

compliance that meets FAA's requirements<sup>2</sup> or 2) be accredited by a nationally recognized accrediting agency or association that meets the U.S. Department of Education's accreditation requirements.

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### Other changes

FAA made other changes in the interim final rule including allowing a school to provide training at additional locations that meet requirements of the regulations; permitting a school to move its primary location outside of the United States or additional locations outside of the United States, according to the final rule; and establishing a minimum pass rate requirement that requires 70 percent of graduates to pass specified tests they take within 60 days of graduation.

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### Industry Stakeholder Viewpoints on Changes Regarding the New Part 147 Interim Final Regulations

Aviation maintenance industry stakeholders we spoke with were generally optimistic about the new interim final regulations for Part 147 but had mixed reactions to certain provisions. Several stakeholders we interviewed—including one repair station and two industry associations—were optimistic that the new regulations would allow schools to offer curriculum that is more technologically modern, adaptive to industry needs, and would better prepare students for working at airlines and repair stations. Despite the general support for moving away from a prescriptive to performance-based curriculum, several stakeholders had differing views on the interim final rule's elimination of minimum-required classroom hours and the effect the shift in oversight could have on the consistency of maintenance programs throughout the country. Representatives we interviewed from an industry association and a school were supportive of eliminating the classroom hours, arguing that the requirement has prevented maintenance schools from operating more efficiently. However, faculty we interviewed from a school expressed concern that by eliminating classroom hour requirements, the interim final rule is effectively reducing the time a student needs to complete the curriculum. Faculty stated that a two-year program, which the hour requirements generally supported, is necessary to develop a professional

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<sup>2</sup>According to the interim final rule, AMT schools must establish quality control systems that include procedures for recordkeeping, assessment, issuing credit, issuing of final course grades, attendance, ensuring sufficient number of instructors, granting of graduation documentation, and corrective action for addressing deficiencies.

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**Appendix IV: Additional Information on  
Changes Regarding the New Title 14 C.F.R.  
Part 147 Interim Final Regulations**

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mechanic and a reduction in instruction time could be detrimental and short sighted for producing qualified mechanics. Furthermore, officials we interviewed from one school expressed concern that offering more flexibility and autonomy in curriculum may result in less standardization of training, negatively effecting the overall output of mechanics. In contrast, an industry group we interviewed told us that increased specialization at schools—for example, certain schools specializing in rotorcraft maintenance, or aircraft parts manufacturing and sheet metal, or aircraft heavy maintenance—would better align with industry needs and be more responsive to local markets.

FAA officials told us that maintenance schools have expressed concern about the transition period from the prior prescriptive-based curriculum to the new performance-based curriculum, especially for current students who will be subject to changes during their education. FAA officials explained that the law mandating the updates to the regulation states that the prior regulations have no force once the new interim final regulations take effect, making it impossible to allow a transition period for schools to phase in the new curriculum gradually.

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## Appendix V: GAO Contact and Staff Acknowledgments

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### GAO Contact

Heather Krause, (202) 512-2834 or [krauseh@gao.gov](mailto:krauseh@gao.gov)

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### Staff Acknowledgments

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